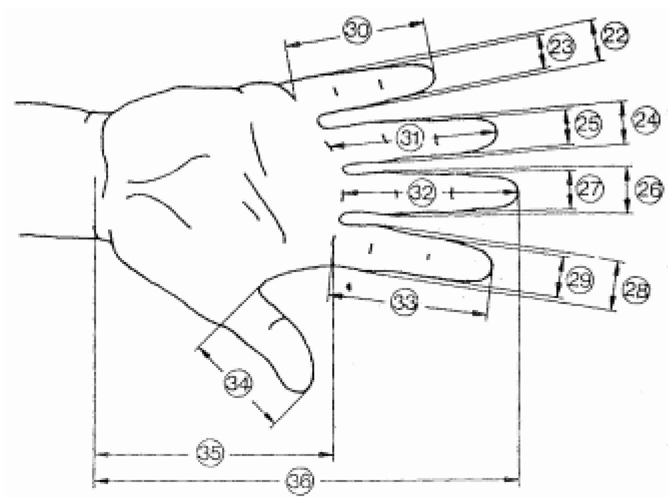
Anexo A

Norma DIN 33 402

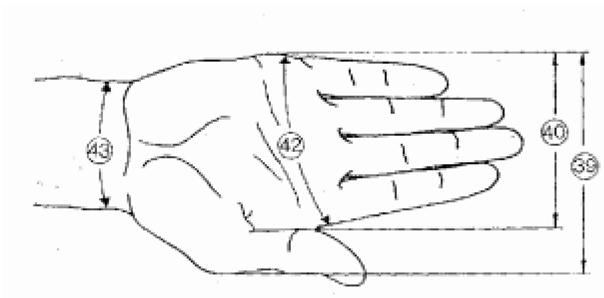
Las dimensiones de las manos tienen una gran importancia para el diseño de herramientas, utillaje y mandos. Ante tal necesidad se estableció la norma DIN 33 402 con el fin de estandarizar estas medidas y poder ser utilizadas en la industria.

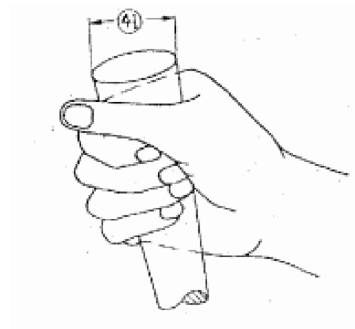
A continuación se muestran las medidas para las manos que esta norma dicta.



Dimensiones En cm.		PERCENTIL						
		Hombres				Mujeres		
		5 %	50 %	95 %		5 %	50 %	95 %
22	Ancho del meñique en la palma de la mano	1,8	1,7	1,8		1,2	1,5	1,7
23	Ancho del meñique próximo de la yema	1,4	1,5	1,7		1,1	1,3	1,5
24	Ancho del dedo anular en la palma de la mano	1,8	2,0	2,1		1,5	1,6	1,8
25	Ancho del dedeo anular próximo a la yema	1,5	1,7	1,9		1,3	1,4	1,6
26	Ancho del dedo mayor en la palma de la mano	1,9	2,1	2,3		1,6	1,8	2,0
27	Ancho del dedo mayor próximo a la yema	1,7	1,8	2,0		1,4	1,5	1,7
28	Ancho del dedo índice en la palma de la mano	1,9	2,1	2,3		1,6	1,8	2,0
29	Ancho del dedo índice próximo a la yema	1,7	1,8	2,0		1,3	1,5	1,7
30	Largo del dedo meñique	5,6	6,2	7,0		5,2	5,8	6,6
31	Largo del dedo anular	7,0	7,7	8,6		6,5	7,3	8,0
32	Largo del dedo mayor	7,5	8,3	9,2		6,9	7,7	8,5
33	Largo del dedo índice	6,8	7,5	8,3		6,2	6,9	7,6
34	Largo del dedo pulgar	6,0	6,7	7,6		5,2	6,0	6,9
35	Largo de la palma de la mano	10,1	10,9	11,7		9,1	10,0	10,8
36	Largo total de la mano	17,0	18,6	20,1		15,9	17,4	19,0

Figura 1. Medidas de los dedos según Norma DIN 33402 (Parte 1)





Dimensiones En cm.		PERCENTIL						
		Hombres				Mujeres		
		5 %	50 %	95 %		5 %	50 %	95 %
37	Ancho del dedo pulgar	2,0	2,3	2,5		1,6	1,9	2,1
38	Grosor de la mano	2,4	2,8	3,2		2,1	2,6	3,1

Dimensiones En cm.		PERCENTIL						
		Hombres				Mujeres		
		5 %	50 %	95 %		5 %	50 %	95 %
39	Ancho de la mano incluyendo dedo pulgar	9,8	10,7	11,6		8,2	9,2	10,1
40	Ancho de la mano excluyendo el dedo pulgar	7,8	8,5	9,3		7,2	8,0	8,5
41	Diámetro de agarre de la mano*	11,9	13,8	15,4		10,8	13,0	15,7
42	Perímetro de la mano	19,5	21,0	22,9		17,6	19,2	20,7
43	Perímetro de la articulación de la muñeca	16,1	17,6	18,9		14,6	16,0	17,7
* Las medidas corresponden al anillo descripto por los dedos pulgar e índice								

Figura 2. Medidas de los dedos según Norma DIN 33402 (Parte 2)

Anexo B
Paper de estimación de fuerza

Handgrip estimation based on total variation denoising filtering for control applications

Julio Reátegui, Gonzalo Cucho, *Member, IEEE*, Paul Rodriguez, Rocio Callupe, *Member, IEEE* and Ericka Madrid, *Member, IEEE*

***Abstract*— In many biomechanical studies and control applications, such as ergonomics studies, control of upper limb prosthesis, and sports performance is required handgrip force estimation for both monitoring and control purposes. As it was proven in previous works, features extraction from the extensor carpi radialis longus (ecrl) sEMG had a linear relationship with the gripforce of the hand. However, most of the developed estimations have shown high variation, which are not quite suitable for control applications. Therefore we propose a methodology to estimate the grip force, which models the extrated features as the handgrip force signal with the presence gaussian noise. In order to estimate the force, these features are filtered with a regularized optimization problem based on total variation denoising (TVD). Furthermore, since TVD is not a trivial minimization problem it was used ADMM algorithm as a meant to implement the proposed methodology. The developed methodology yielded promising results ($\rho > 0.94$ $NRMSE < 0.07$) between $30\% - 50\%$ MVC.**

I. INTRODUCTION

For a long time in fields such as biomechanics, clinical diagnosis, ergonomics, sports performance, and rehabilitation robotics [1], handgrip estimation had proven to be a valuable tool for clinical diagnosis and control applications. In clinical diagnosis the grip force is typically estimated in an off-line fashion after the experiments. However, in control applications such as prosthesis or exoskeleton control it is not an option, and there is a necessity for real-time force estimation.

Force estimation problem has been addressed by diverse approaches for force estimation, using different methodologies and models (i.e. [2][3][4]). Mostly based on feature extraction from the superface electromyography (sEMG) of a specific muscle or a group of muscles. Although some of these approaches had promising results, the estimation process gets more complex and its harder to implement. It can be seen mainly for those which use additional input variables [5], or its estimations systems are based on learning algorithms, that they need a great amount of data to generate a good predictor. On the other hand, some methods [6][7][8] estimates the force with extracted features from the sEMG of the forearm muscles, that have a linear relationship with the force. However, in most of the cases, to obtain these features its necessary a large window of data per feature, to make a good estimation. On the contrary the estimation presents a reduced correlation and the presence of abrupt changes.

We propose a novel methodology to estimate the handgrip-force based on the filtering of extracted features. This method extracts features from the sEMG signal, in a continous manner, obtained from the extensor carpi radialis longus (ecrl), that had a linear relationship with the measured force of the handgrip. In order to estimate the force, the extracted features are considered as the handgrip force signal corrupted by gaussian noise, and then their are filtered with a minimization problem based on total variation denoising (TVD). TVD is a noise reduction approach developed to preserve sharp edges on images. However, it is not restricted only to images, and it has proven to be a powerful tool for 1D signal denoising [9]. In addition, since TVD has no trivial minimization solution, the present work has considered the alternating direction method of multipliers (ADMM) as a minimization algorithm, in order to present a implementation proposal.

The paper is structured as follow: sec.II gives a brief review about TVD and ADMM, sec. III presents the proposed methodo, sec. IV presents the methodology to evaluate the data and the parameters used, and the paper is concluded with with the experimental results, the discution and the conclusion.

II. BACKGROUND

In this section, the theoretical background of total variation and ADMM will be presented due its main role in the proposed methodology.

A. Total Variation Denoising

Total variation denoising (TVD) is an approach for noise reduction developed to preserve sharp edges in the underlying signal [10]. In contrast of conventional low-pass filter, TV denoising is defined in terms of an optimization problem, based on a cost function. Any algorithm capable to solve the optimization problem can be used to implement TV denoising. However, it is not trivial because the TVD cost

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function is non-differentiable given the presence of the L1 norm. Numerous algorithms have been developed to solve the TVD problem [11]. TVD assumes that the noise or observed data b is of the form:

$$b = x + w \tag{1}$$

Where x is a (approximately) piecewise constant signal and w is white Gaussian noise. The TVD estimates the signal x by solving the optimization problem.

$$\underset{x}{\text{argmin}} \frac{1}{2}\|x-b\|_2^2 + \lambda\|Dx\|_1 \tag{2}$$

Where $x \in R^n$ is the estimated signal and $b \in R^n$ is the noisy observed signal, D is the differential operator and λ is the regularization term. The regularization term $(\lambda > 0)$ controls the degree of smoothing. An Increase in λ results in an increase of the restriction made by the second term, which measures the variation of the signal x.

B. Alternating Direction Method of Multipliers (ADMM)

In this section we give an overview of ADMM based on [12].

1) ADMM standard algorithm: The standard ADMM algorithm solves problems in the form:

$$\begin{array}{ll} \text{minimize} & f(x) + g(z) \\ \text{subject to} & Ax + Bz = c \end{array} \tag{3}$$

Where $x \in R^n$, $z \in R^m$, matrices $A \in R^{pxn}$, $B \in R^{pxm}$ and vector $c \in R^p$. Similar to the method of multiplier, the problem uses the augmented lagrandian to find a solution.

$$\begin{aligned} L_\rho(x,z,y) = f(x) + g(z) + y^T(Ax+Bz-c) \\ +\frac{\rho}{2}\|Ax+Bz-c\|_2^2 \end{aligned} \tag{4}$$

Where y is the lagrange multiplier corresponding to the equality constrain and ρ is the penalty parameter. The minimization process starts with an initial point (x^0, z^0, y^0) and $(0 \leq k)$. Then it is followed by these iterative steps:

$$x^{k+1} := \underset{x}{\text{argmin}}\, L_\rho(x, z^k, y^k) \tag{5}$$

$$z^{k+1} := \underset{z}{\text{argmin}}\, L_\rho(x^{k+1}, z, y^k) \tag{6}$$

$$y^{k+1} := y^k + \rho(Fx^{k+1} + Dz^{k+1} - c) \tag{7}$$

However this representation can be expressed in a more convenient way, by transforming the last two term of (4) into:

$$\begin{aligned} y^T(Ax+Bz-c) + \frac{\rho}{2}\|Ax+Bz-c\|_2^2 = \\ \frac{\rho}{2}\|Ax+Bz-c+\frac{y}{\rho}\|_2^2 - \frac{1}{2\rho}\|y\|_2^2 \end{aligned} \tag{8}$$

and using the relation $u = \frac{y}{\rho}$ (5), (6) and (7) are modified as:

$$x^{k+1} := \underset{x}{\text{argmin}}\left(f(x) + \frac{\rho}{2}\|Ax+Bz-c+u\|_2^2\right) \tag{9}$$

$$z^{k+1} := \underset{z}{\text{argmin}}\left(g(z) + \frac{\rho}{2}\|Ax+Bz-c+u\|_2^2\right) \tag{10}$$

$$u^{k+1} := u^k + Ax + Bz - c \tag{11}$$

2) Total Variation implementation in ADMM: As it is stated in [12] total variation denoising (2) can be expressed in ADMM form as follow:

$$\begin{array}{ll} \text{minimize} & \frac{1}{2}\|x-b\|_2^2 + \lambda\|z\|_1 \\ \text{subject to} & Dx - z = 0 \end{array} \tag{12}$$

This leads to the iteration steps:

$$x^{k+1} = (I + \rho D^T D)^{-1}(b + \rho D^T(z^k - u^k)) \tag{13}$$

$$z^{k+1} = S_{\frac{\lambda}{\rho}}(Dx^{k+1} - u^k) \tag{14}$$

$$u^{k+1} = u^k + Dx^{k+1} - z^{k+1} \tag{15}$$

Where S is a soft thresholding function whose, threshold parameter is equal to $\frac{\lambda}{\rho}$.

III. Force Estimation Method

Our method consist of two parts. First, sEMG and grip force recording, features extraction, filtering and linear model generation. Second, sEMG recording, features extraction filtering, data scaling and force estimation. The first stage of the method is necesary only once to generate a linear model for the data scaling. the second stage uses this model to scale the data and to estimate the force.

3) Features Extraction: The initial stage of the algorithm consists in acquiring the data and features extraction, (16).

$$X_i = \sum_{j=1}^{m} |x_j| \tag{16}$$

Where $x \in R^n$, m is the length of the subgroup of the data $(m < n)$ and X_i is L_1 norm of group of data. This features is used to extract informacion about the mean of small sections of data of an acquire window of time. Also reduces the amount of data to be used in the filtering process and to effect of large variations.

4) Filtering Process: Since this estimator has been considered for control processes, we require to obtain a smooth signal in a continuous fashion. This presents two challenges, the first one is to obtain a smooth signal with reduced variations or oscillations and the second, is to achieve this estimations in a small amount of time. To be able to deal with the first issue we take advantage of the regularization term of TVD, however this only assures the smoothing the values of window of data and not variations between the data of adjacent windows. This issue is handled by adding a regularization term which penalizes the variation between adjacent windows. In addition the boundary conditions will also present a problem between estimations in order to minimize this effects the methodology considers overlapping windows in each estimation. The second requirement can be easily achieved by using a small entry of data in each estimation, however this can present a negative effect in the estimation. This leads to the proposed optimization problem expressed in (17).

$$\text{minimize} \quad \frac{1}{2}\|x-b\|_2^2 + \frac{\beta}{2}\|D_{Ad}x\|_2^2 + \lambda\|Dx\|_1 \tag{17}$$

Where $x \in R^n$ is the filtered signal, $b \in R^n$ is the input signal, $D_{Ad} \in R^{nxn}$ is a differentation matrix between new and the previous estimation and β is a regularization term used to penalize this new restriction. D_{Ad} is a matrix used tu reduce the variation between the new estimated data and the previous estimations. This is done by subtracting its features term by term.

$$D_{Ad} = \underbrace{\begin{pmatrix} 0 & 0 & \cdots & \cdots & 0 & & \cdots & 0 & \cdots & 0 \\ 0 & \ddots & \ddots & & \ddots & \ddots & \ddots & & & \vdots \\ \vdots & \ddots & 0 & \ddots & & \ddots & 0 & \ddots & \cdots & 0 \\ 0 & \cdots & 0 & -1 & 0 & \cdots & 0 & 1 & \ddots & \vdots \\ \vdots & & & \ddots & \ddots & \ddots & & \ddots & \ddots & 0 \\ 0 & \cdots & \cdots & \cdots & 0 & -1 & 0 & \cdots & 0 & 1 \end{pmatrix}}_{2q} \begin{matrix} \left.\right\} pq \\ \left.\right\} q \end{matrix}$$

where q is the length of the features extracted from a window of data and p is the number of previous data estimations. In order to use the proposed methodology is necessary to record an initial data set. This can be done by recording p windows of data, extracting its features and filtering it with TVD. Once the required number of overlapping windows are recorded, (17) can be used. For this case, the input data is a vector formed by the features of previous estimations and the ones from a new data reading. The filtered data will be formed by a vector with smoothed features from the previous estimation and the new data. This last dataset is the *"not scaled estimations"* of the recorded window. This dataset will pass to the next stage of the estimation, and also be used as part of the previous data, for futures estimations.

Equation (17) in ADMM form is:

$$\begin{aligned} &\text{minimize} \quad \frac{1}{2}\|x-b\|_2^2 + \frac{\beta}{2}\|D_{Ad}x\|_2^2 + \lambda\|z\|_1 \\ &\text{subject to} \quad Dx - z = 0 \end{aligned} \tag{18}$$

and can be implemented using the following iteration steps:

$$x^{k+1} = (I + \rho D^T D + \beta D_{Ad}^T D_{Ad})^{-1}(b + \rho D^T(z^k - u^k)) \tag{19}$$

$$z^{k+1} = S_{\frac{\lambda}{\rho}}(Dx^{k+1} - u^k) \tag{20}$$

$$u^{k+1} = u^k + Dx^{k+1} - z^{k+1} \tag{21}$$

5) Data Scaling: The extracted features as presented in [6] can be scaled using a linear model, to this purpose we use linear regression based on least squares (22) to obtain the coefficientes of the model.

$$\frac{1}{2}\|Ax - b\|_2^2 \tag{22}$$

where $A \in R^{nx2}$ is a matrix formed with the filtered data and a vector of ones, $x \in R^2$ are the coefficients of the linear model and $b \in R^n$ is the measured force.

$$\mathbf{A} = \begin{bmatrix} x_0 & 1 \\ \vdots & \vdots \\ x_{n-2} & 1 \\ x_{n-1} & 1 \end{bmatrix}, \quad \mathbf{x} = \begin{bmatrix} a \\ b \end{bmatrix}, \quad \mathbf{b} = \begin{bmatrix} b_0 \\ \vdots \\ b_{n-2} \\ b_{n-1} \end{bmatrix}$$

To be able to generate the coefficientes it is necessary an initial data reading, once generated the coefficientes can be used to scale the data from the filtered features.

IV. Methodology

A. Participants

In order to realize the tests, four participant were recruited (three males and one female). All the subjects are self-report righ-handed with no history of musculoskeletal disorders. Their age ranged from 25 to 28 and had a MVC range from 120N to 260N. The force tasks where constant force contractracion of 2.5 and 5 seconds of durations. Between each trail the subjects had a rest of 1 minute. Taking into account the linear relationship between the features and the forces is higher between $30\% - 50\%$ MVC [8], it was analyzed only this range of force.

B. Acquisition Parameters

The experimental superficial EMG signal was recorded from the extensor carpi radialis longus, due its high correlation with the handgrip force [8]. BioPac system was use for data acquisition. EMG100c module enables us to register one cannel of sEMG signal at 1Khz simple rate and filtered band 10-500 Hz. The superficial electrodes used where standard Ag/Agcl of the 3M brand (2228). To register gripping force it was used the isometric dynamometer TSD121c and the general purpose transducer amplifier DA100c.

C. Experiment Set up

In order to applied the method we record raw sEMG data and grip force data with the Biopac system. All the obtained data was processed in a standard PC over the Matlab environment. The measured force has been normalized with the maximum voluntary contraction (MVC). In order to generate the linear model, it has been recorded a five seconds (5s) window of sEMG and grip force. Both signals where filtered, with the proposed methodology (only feature extraction, filtering) and low pass filtering respectively.

Finally, the scaled force is used to calculate the coefficients. As in the initial stage, all the filtering stages consider a $100ms$ time window and four windows of previous estimated data, and from each readed window of data there are extracted four features ($25ms$). The regularization term λ was considered a linear function of the standard deviation from the data input. Finally for the parameters of the proposed method it was used aβ and ρ with constant value equal to 0.1 and $1e5$ respectively.

V. Experiment Results

The extracted features of the 5 seconds window sEMG data, were filtered with the designed filter Fig. 1, and then it was scaled with the force pattern as show in Fig. 2. Ones obtained the linear model it is used for further estimations as seen in Fig. 3, where it can be used for differente patterns of force which are in the range of $30\% - 50\%$ MVC.

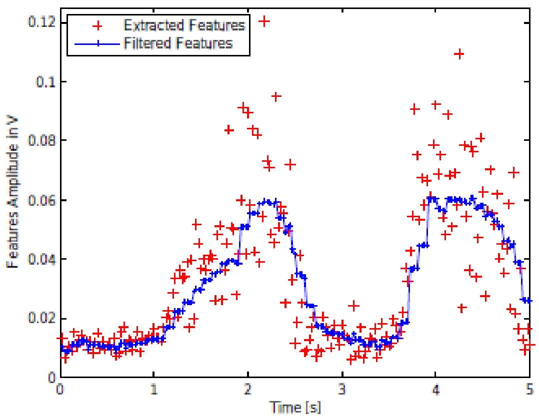


Fig. 1. Initialization stage of the estimation: extracted features (red crosses) from the recorded EMG window and the filtered features (blue crosses) using (17)

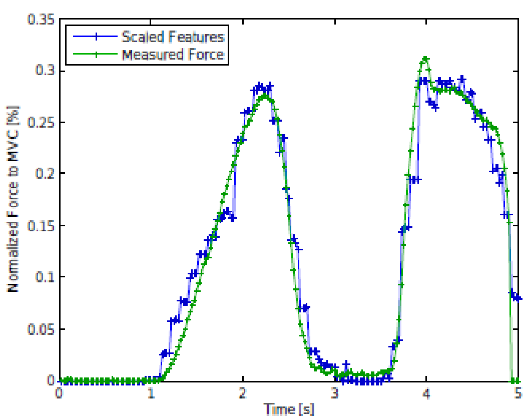


Fig. 2. Initialization stage of the estimation: scaled data (??) (blue line with blue cross) compared with the real measured force (green line green cross) ($\rho = 0.98 \& NRMSE = 0.02$).

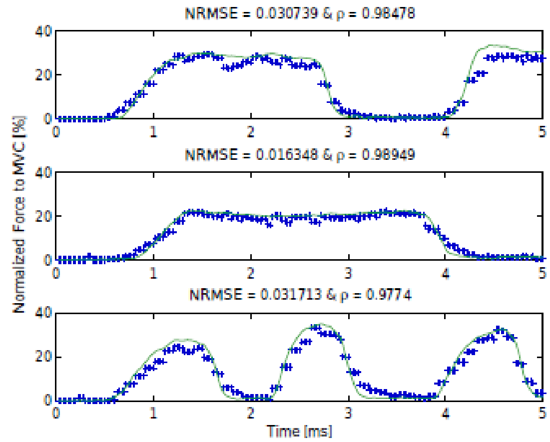


Fig. 3. Grip Force estimations generated with the modeleq. (??) from the initial data set. where the green line represents the real force and the blue crosses the estimated data

In order to show the benefits of filtering the extracted features with the proposed filter (17), it was compared with a low pass filter (Fir filter with cuf-off frequency 100Hz). Fig.4 shows the comparison of filtering the features with the proposed method and a low pass filter. It can be see that both methods show good results, however the proposed methodology show less abrupt changes and a more flat response than the estimation obtained with the low pass filter. On the other hand table I and table II, exhibit the statistical results for the NRMSE and the correlation of the estimations. The tables show that the numerical results of the proposed method are slightly better than the ones obtained with low pass filtering.

TABLE I
Statistical results for the NRMSE of the estimation for the proposed method and low pass filtering

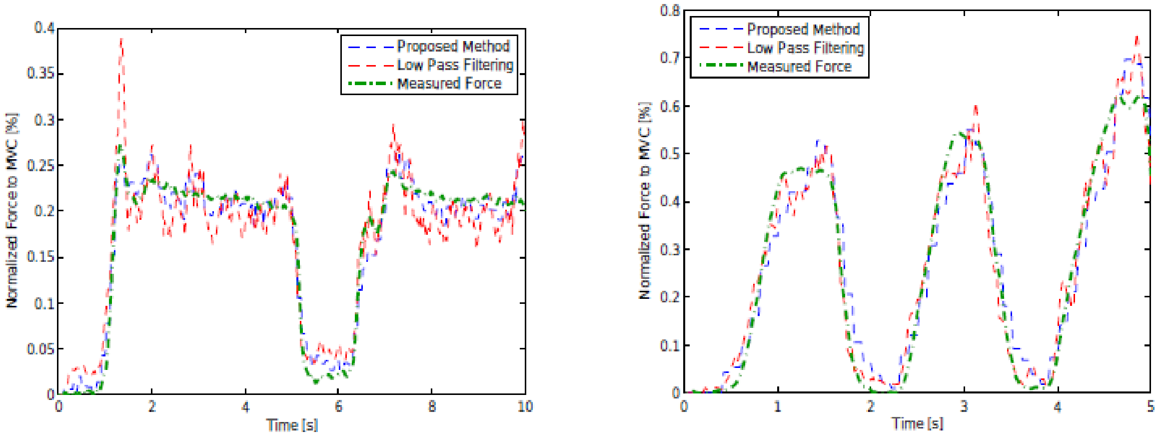
Method	Min	Max	Mean	Std. dev.
Proposed	0.02	0.07	0.048	0.021
Low Pass Filtering	0.03	0.09	0.048	0.023

TABLE II
Statistical results for the Correlation of the estimation for the proposed method and low pass filtering

Method	Min	Max	Mean	Std. dev.
Proposed	0.94	0.98	0.96	0.01
Low Pass Filtering	0.89	0.99	0.95	0.03

VI. Discussion

The proposed method present promising results for hand-grip force estimation. However, more test must be done including other initial data set or considering different force



(a) (b)

Fig. 4. Method comparison with different force traces. a) Blue dashed line represents the estimation of the force using the proposed methodology ($\rho = 0.98 \& NRMSE = 0.02$), red dashed line the data estimation with a low pass filter($\rho = 0.94 \& NRMSE = 0.03$) and the green line dashed line with dots the measured force. b) Blue dashed line represents the estimation of the force using the proposed methodology ($\rho = 0.97 \& NRMSE = 0.05$), red dashed line the data estimation with a low pass filter($\rho = 0.98 \& NRMSE = 0.04$) and the green line dashed line with dots the measured force.

ranges, in order to assure the sturdiness of the method. Another important point to be considered is the assumption of the presence of gaussian noise in the extracted features, TVD is designed to eliminate gaussian noise, in the presence of other noises there is no garanty that it will work. Its pendent a correct analisis or modeling of noise in the extracted features, in order to assure the use of TVD.

VII. Conclusion

In this paper, the authors have proposed a method for estimating handgrip force based on the sEMG of the $ecrl$. The simulations show the potential of the proposed methodology, with low normalized rms errors $nrmse < 0.07$ and aceptable correlations $\rho > 0.94$. In addition, the proposed methodology presented a flatter estimation in comparison of the obtained with only low pass filtering even thought it had a little less NRMSE. Furthermore, it was presented the algorithm for the method based on ADMM, which can be implemented easily on embedded systems. Finally, the present method does not rely on additional variables, or extra sensors.

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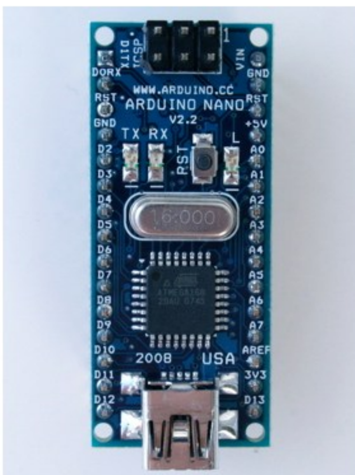
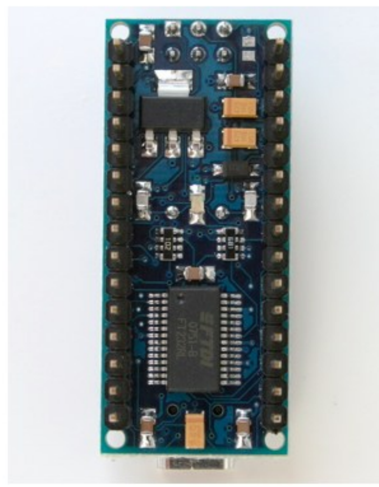
Anexo C

Hoja de datos Arduino Nano 3.0

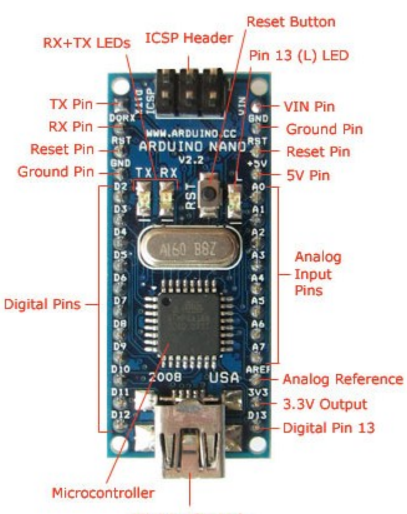
Arduino Nano

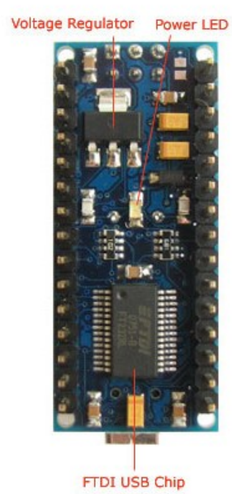




Descripción General

El Arduino Nano es una pequeña y completa placa basada en el ATmega328 (Arduino Nano 3.0) o ATmega168 (Arduino Nano 2.x) que se usa conectándola a una protoboard. Tiene más o menos la misma funcionalidad que el Arduino Duemilanove, pero con una presentación diferente. No posee conector para alimentación externa, y funciona con un cable USB Mini-B en vez de el cable estandar. El nano fue diseñado y está siendo producido por Gravitech.





Esquemático y Diseño

Arduino Nano 3.0 (ATmega328): Esquemático, Archivos Eagle.
Arduino Nano 2.3 (ATmega168): manual (pdf), Archivos Eagle. *Nota:* debido a que la versión gratuita de Eagle no permite trabajar con más de dos capas, y esta versión del Nano posee 4 capas, se ha publicado aquí sin ser enrutado, así los usuarios pueden abrirlo y usarlo en la versión gratuita de Eagle.

Especificaciones:

Microcontrolador	Atmel ATmega168 o ATmega328
Tensión de Operación (nivel lógico)	5 V
Tensión de Entrada (recomendado)	7-12 V
Tensión de Entrada (límites)	6-20 V
Pines E/S Digitales	14 (de los cuales 6 proveen de salida PWM
Entradas Analógicas	8
Corriente máx por cada PIN de E/S	40 mA
Memoria Flash	16 KB (ATmega168) o 32 KB (ATmega328) de los cuales 2KB son usados por el bootloader
SRAM	1 KB (ATmega168) o 2 KB (ATmega328)
EEPROM	512 bytes (ATmega168) o 1 KB (ATmega328)
Frecuencia de reloj	16 MHz
Dimensiones	18,5mm x 43.2mm

Alimentación:

El Arduino Nano puede ser alimentado usando el cable USB Mini-B , con una fuente externa no regulada de 6-20V (pin 30), o con una fuente externa regulada de 5V (pin 27). La fuente de alimentación es seleccionada automáticamente a aquella con mayor tensión.
El chip FTDI FT232RL que posee el Nano solo es alimentado si la placa esta siendo alimentada usando el cable USB. como resultado, cuando se utiliza una fuente externa (no USB), la salida de 3.3V (la cual es proporcionada por el chip FTDI) no está disponible y los pines 1 y 0 parpadearán si los pines digitales 0 o 1 están a nivel alto.

Memoria

El ATmega168 posee 16KB de memoria flash para almacenar el codigo (de los cuales 2KB son usados por el bootloader); el ATmega 328 posee 32KB, (también con 2 KB usados por el bootloader). El Atmega168 posee 1KB de SRAM y 512 bytes de EEPROM (la cual puede ser leida y escrita con la librería EEPROM); el ATmega328 posee 2 KB de SRAM y 1KB de EEPROM.

Entrada y Salida

Cada uno de los 14 pines digitales del Nano puede ser usado como entrada o salida, usando las funciones pinMode(), digitalWrite(), y digitalRead(). Operan a 5 voltios. Cada pin puede proveer o recibir un máximo de 40mA y poseen una resistencia de pull-up (desconectada por defecto) de 20 a 50 kOhms. Además algunos pines poseen funciones especializadas:

- **Serial: 0 (RX) y 1 (TX).** (RX) usado para recibir y (TX)usado para transmitir datos TTL vía serie. Estos pines están conectados a los pines correspondientes del chip USB-a-TTL de FTDI.
- **Interrupciones Externas: pines 2 y 3.** Estos pines pueden ser configurados para activar una interrupción por paso a nivel bajo, por flanco de bajada o flanco de subida, o por un cambio de valor. Mira la función attachInterrupt() para más detalles.
- **PWM: pines 3, 5, 6, 9, 10, y 11.** Proveen de una salida PWM de 8-bits cuando se usa la función analogWrite().
- **SPI: pines 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).** Estos pines soportan la comunicación SPI, la cual, a pesar de poseer el hardware, no está actualmente soportada en el lenguaje Arduino.
- **LED: Pin 13.** Existe un LED conectado al pin digital 13. Cuando el pin se encuentra en nivel alto, el LED está encendido, cuando el pin está a nivel bajo, el LED estará apagado.

El Nano posee 8 entradas analógicas, cada unas de ellas provee de 10 bits de resolución (1024 valores diferentes). Por defecto miden entre 5 voltios y masa, sin embargo es posible cambiar el rango superior usando la función analogReference(). También, algunos de estos pines poseen funciones especiales:

- **I^2C: Pines 4 (SDA) y 5 (SCL).** Soporta comunicación I^2C (TWI) usando la librería Wire (documentación en la web Wiring).

Hay algunos otros pines en la placa:

- **AREF.** Tensión de referencia por las entradas analógicas. Se configura con la función analogReference().
- **Reset.** Pon esta linea a nivel bajo para resetear el microcontrolador. Normalmente se usa para añadir un botón de reset que mantiene a nivel alto el pin reset mientras no es pulsado.

Mira también el cableado entre los pines Arduino y los puertos del ATmega168.

Comunicación

El Arduino Nao tiene algunos métodos para la comunicación con un PC, otro Arduino, u otros microcontroladores. El ATmega168 y el ATmega328 poseen un módulo UART que funciona con TTL (5V)el cual permite una comunicación vía serie, la cual está disponible usando los pines 0 (RX) y 1 (TX). El chip FTDI FT232RL en la placa hace de puente a través de USB para la comunicación serial y los controladores FTDI (incluidos con el software de Arduino) provee al PC de un puerto com vitual para el software en el PC. El software Arduino incluye un monitor serial que permite visualizar en forma de texto los datos enviados desde y hacia la placa Arduino. Los LEDs RX y TX en la placa parpadearán cuando los datos se estén enviando a través del chip FTDI y la conexión USB con el PC (Pero no para la comunicación directa a través de los pines 0 y 1)

La librería SoftwareSerial permite llevar a cabo una comunicación serie usando cualquiera de los pines digitales del Nano. El ATmega168 y el ATmega328 también soporta comunicación I2C (TWI) y SPI. El software Arduino incluye la librería Wire para simplificar el uso del bus I2C; mira la documentación para más detalles. Para usar la comunicación SPI, por favor mira la hoja de datos del ATmega168 o el ATmega328.

Programación

El Arduino Nano puede ser programado con el software de Arduino (descarga). Selecciona "Arduino Diecimila, Duemilanove, o Nano w/ ATmega168" o "Arduino Duemilanove or Nano w/ ATmega328" de el menú **Tools > Board** (seleccionando el modelo del microcontrolador en tu placa). Para más detalles, mira la referencia y los tutoriales.

El ATmega168 o ATmega328 del Arduino Nano vienen preprogramados con un bootloader que te permite subir tu código al Arduino sin la necesidad de un programador externo. Se comunica usando el protocolo STK500 original (referencia, Archivos cabecera C).

También puedes programar el microcontrolador usando un programador ICSP (In-Circuit Serial Programming, Pogramación Serie En-Circuito); visita estasinstrucciones para más detalles.

Reset Automático (Software)

En vez de necesitar pulsar un botón físico de reset, el Arduino Nano ha sido diseñado de tal manera que permite ser reseteado por el software del PC al que está conectado. Una de las líneas de control de flujo por hardware (DTR) del chip FT232RL está conectada a la línea de reset del ATmega168 o ATmega328 a través de un condensador de 100 nanofaradios. Cuando esta línea se pone a nivel bajo, la linea de reset se mantiene a nivel bajo el suficiente tiempo para causar el reset del chip. El software de Arduino usa esta capacidad para permitir cargar código en el Arduino pulsando simplemente el botón "upload" en el entorno software de Arduino. Esto significa que el tiempo de espera del bootloader es más pequeño, ya que el tiempo en el que se encuentra a nivel bajo el DTR puede ser cordinado bien con el inicio de la carga del código.

Esta configuración tiene otras implicaciones. Cuando el Nano se conecta a un PC que funciona con Mac OS X o Linux, se resetea cada vez que se hace la conexión con el software (a través del USB). Durante el siguiente medio segundo más o menos, el bootloader está corriendo en el Nano. Como el bootloader ha sido para programado para ignorar cualquier dato erróneo (cualquier dato que no sea la carga de nuevo código), por lo tanto ignorará los primeros bytes que se reciban justo después de hacer la conexión. Si un sketch cargado en la placa recibe algún tipo de configuración o algún otro tipo de dato importante nada más iniciarse, asegúrate de que el software con el que se comunique, espere al menos un segundo antes de enviar datos para que no sean ignorados por el bootloader.

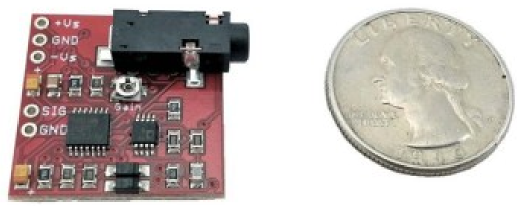
Share

Anexo D
Hojas de Datos sensor de músculo

Sensor de músculo

Muscle Sensor v3

Advancer Technologies
Advancing the Future



Three-lead Differential Muscle/Electromyography Sensor for Microcontroller Applications

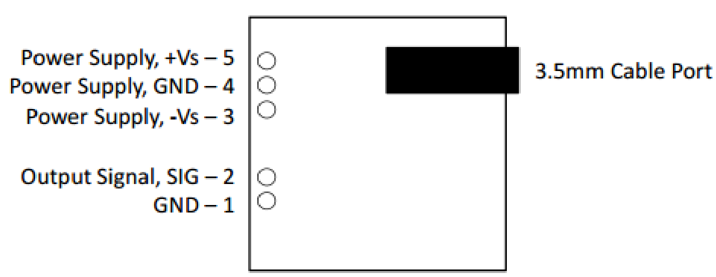
FEATURES
- Small Form Factor (1inch X 1inch)
- Specially Designed For Microcontrollers
- Adjustable Gain – Improved Ruggedness
- New On-board 3.5mm Cable Port
- Pins Fit Easily on Standard Breadboards

APPLICATIONS
- Video games
- Robots
- Medical Devices
- Wearable/Mobile Electronics
- Powered Exoskeleton suits

What is electromyography?

Measuring muscle activation via electric potential, referred to as electromyography (EMG), has traditionally been used for medical research and diagnosis of neuromuscular disorders. However, with the advent of ever shrinking yet more powerful microcontrollers and integrated circuits, EMG circuits and sensors have found their way into prosthetics, robotics and other control systems.

PIN LAYOUT



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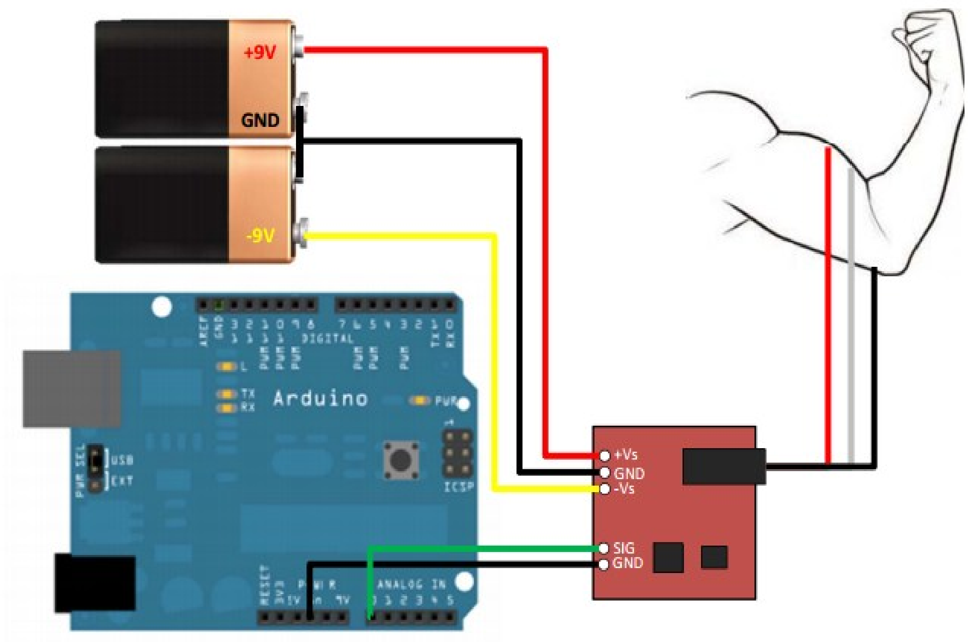
Getting Started Using Two 9V Batteries



1) Connect the power supply (two 9V batteries)
   a. Connect the positive terminal of the first 9V battery to the +Vs pin on your sensor.
   b. Connect the negative terminal of the first 9V battery to the positive terminal of the second 9V battery. Then connect to the GND pin on your sensor.
   c. Connect the negative terminal of the second 9V battery to the –Vs pin of your sensor.
2) Connect the electrodes
   a. After determining which muscle group you want to target (e.g. bicep, forearm, calf), clean the skin thoroughly.
   b. Place one electrode in the middle of the muscle body, connect this electrode to the RED Cable's snap connector.
   c. Place a second electrode at one end of the muscle body, connect this electrode to the Blue Cable's snap connector.
   d. Place a third electrode on a bony or non-muscular part of your body near the targeted muscle, connect this electrode to the Black Cable's snap connector.
3) Connect to a Microcontroller (e.g. Arduino)
   a. Connect the SIG pin of your sensor to an analog pin on the Arduino (e.g. A0)
   b. Connect the GND pin of your sensor to a GND pin on the Arduino.

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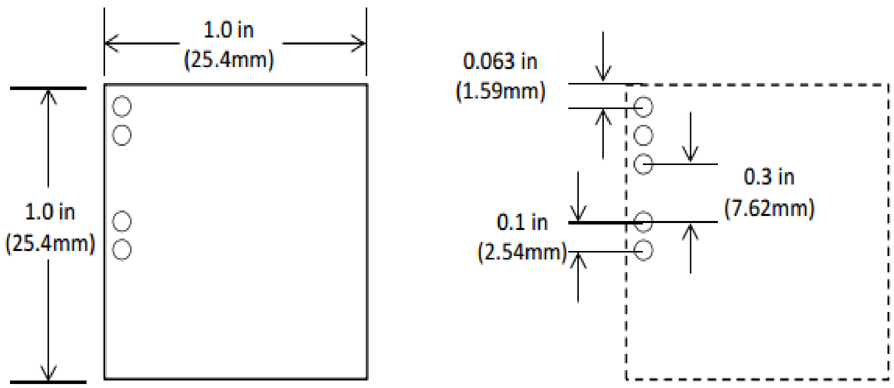
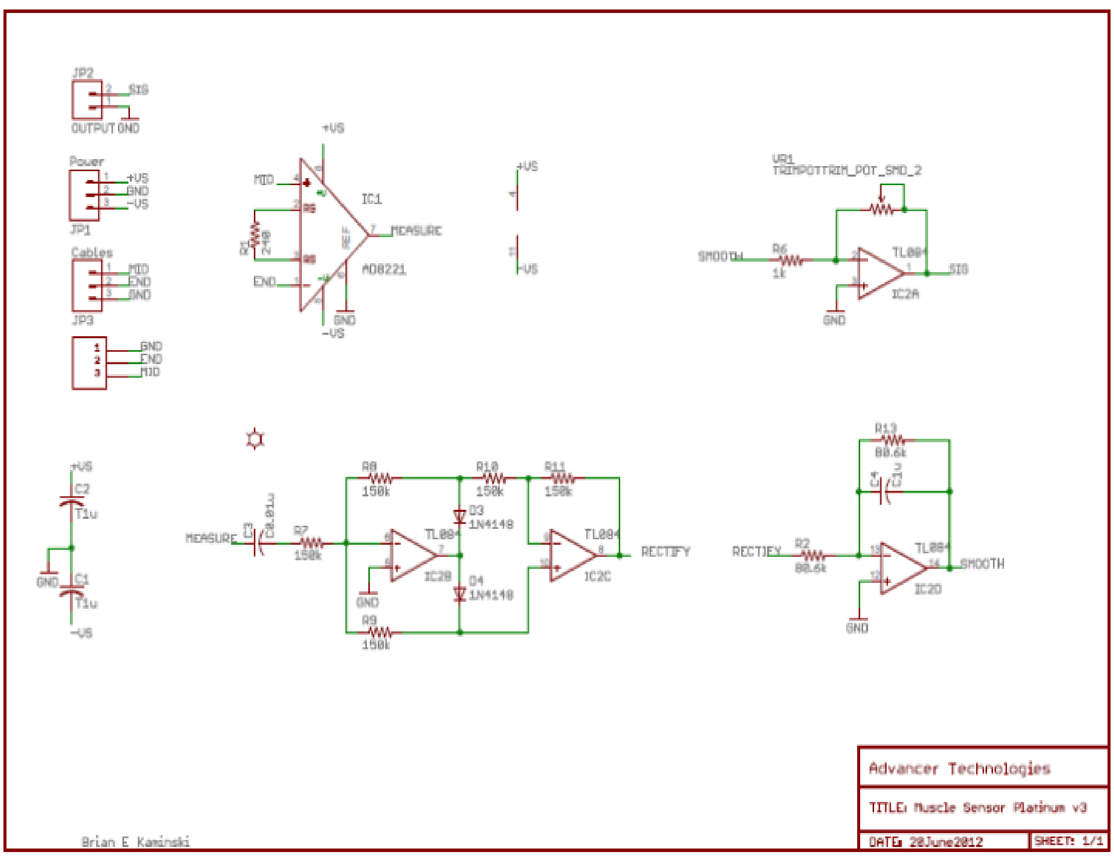
Dimensions



Circuit Schematic



Electrical Specifications

Parameter	Min	TYP	Max
Power Supply Voltage (Vs)	±3V	±5V	±30V
Gain Setting, Gain = 207*(X /1 kΩ)	0.01 Ω (0.002x)	50 kΩ (10,350x)	100 kΩ (20,700x)
Output Signal Voltage (Rectified & Smoothed)	0V	--	+Vs
Differential Input Voltage	0 mV	2-5mV	+Vs/Gain

ELECTROSTATIC DISCHARGE SENSITIVITY

This sensor can be damaged by ESD. Advancer Technologies recommends that all sensors be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

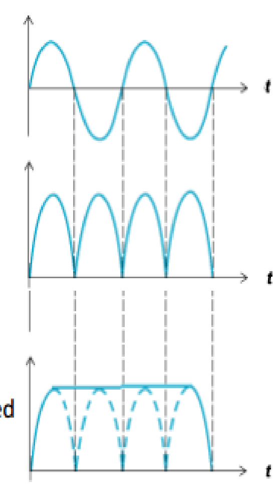
RAW EMG vs Rectified & Smoothed EMG

Our Muscle Sensors are designed to be used directly with a microcontroller. Therefore, our sensors do not output a RAW EMG signal but rather an amplified, rectified, and smoothed signal that will work well with a microcontroller's analog-to-digital converter (ADC). This difference can be illustrated by using a simple sine wave as an example.

RAW Sine Wave

Full Wave Rectified Sine Wave

Rectified & Smoothed Sine Wave

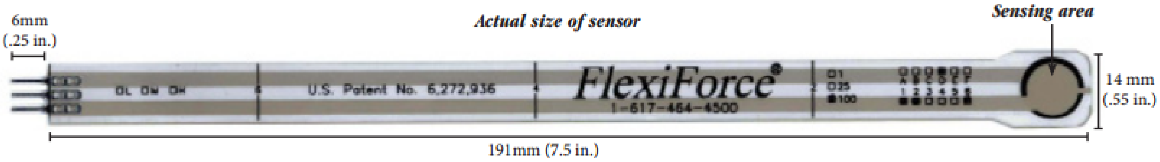


Anexo E

Hojas de Datos sensor de fuerza

Sensor de fuerza

FlexiForce®
Standard Force & Load Sensors Model # A201



Physical Properties

Thickness	0.203 mm (0.008 in.)
Length	191 mm (7.5 in.)*
	optional trimmed lengths: 152 mm (6 in.), 102 mm (4 in.), 51 mm (2 in.)
Width	14 mm (0.55 in.)
Sensing Area	9.53 mm (0.375 in.) diameter
Connector	3-pin Male Square Pin (center pin is inactive)
Substrate	Polyester (ex: Mylar)
Pin Spacing	2.54 mm (0.1 in.)

✓ ROHS Compliant

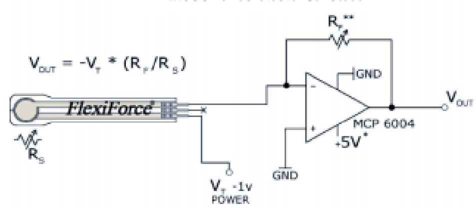
** Length does not include pins, please add approximately 6mm (0.25 in.) for pin length for a total length of approximately 197 mm (7.75 in).*

Standard Force Ranges (as tested with circuit shown below)

0 - 1 lb. (4.4 N)
0 - 25 lb. (111 N)
0 - 100 lb. (445 N)

In order to measure forces above 100 lb (up to 1000 lb), apply a lower drive voltage (-0.5 V, -0.10 V, etc.) and reduce the resistance of the feedback resistor (1kΩ min.) Conversely, the sensitivity can be increased for measurement of lower forces by increasing the drive voltage or resistance of the feedback resistor.

Recommended Circuit



- * Supply Voltages should be constant
- ** Reference Resistance R_F is 1kΩ to 100kΩ
- Sensor Resistance R_S at no load is >5MΩ
- Max recommended current is 2.5mA

Typical Performance Evaluation Conditions

Linearity (Error)	< ±3%	Line drawn from 0 to 50% load
Repeatability	< ±2.5% of full scale	Conditioned sensor, 80% of full force applied
Hysteresis	< 4.5 % of full scale	Conditioned sensor, 80% of full force applied
Drift	< 5% per logarithmic time scale	Constant load of 25 lb (111 N)
Response Time	< 5µsec	Impact load, output recorded on oscilloscope
Operating Temperature	-40°F - 140°F (-40°C - 60°C)	*Time required for the sensor to respond to an input force*

*Force reading change per degree of temperature change = ±0.2%/°F (0.36%/°C)

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Tekscan

Rev N_9.30.13

Anexo F

Hojas de Datos Amplificador MCP 6004

Amplificador MCP 6004
(Placa de interconexiones entre los sensores de presión y el microcontrolador)

MICROCHIP

MCP6001/1R/1U/2/4

1 MHz, Low-Power Op Amp

Features

- Available in SC-70-5 and SOT-23-5 packages
- Gain Bandwidth Product: 1 MHz (typical)
- Rail-to-Rail Input/Output
- Supply Voltage: 1.8V to 6.0V
- Supply Current: I_Q = 100 µA (typical)
- Phase Margin: 90° (typical)
- Temperature Range:
  - Industrial: -40°C to +85°C
  - Extended: -40°C to +125°C
- Available in Single, Dual and Quad Packages

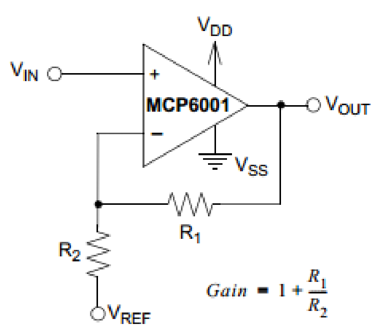
Applications

- Automotive
- Portable Equipment
- Photodiode Amplifier
- Analog Filters
- Notebooks and PDAs
- Battery-Powered Systems

Design Aids

- SPICE Macro Models
- FilterLab® Software
- Mindi™ Circuit Designer & Simulator
- Microchip Advanced Part Selector (MAPS)
- Analog Demonstration and Evaluation Boards
- Application Notes

Typical Application



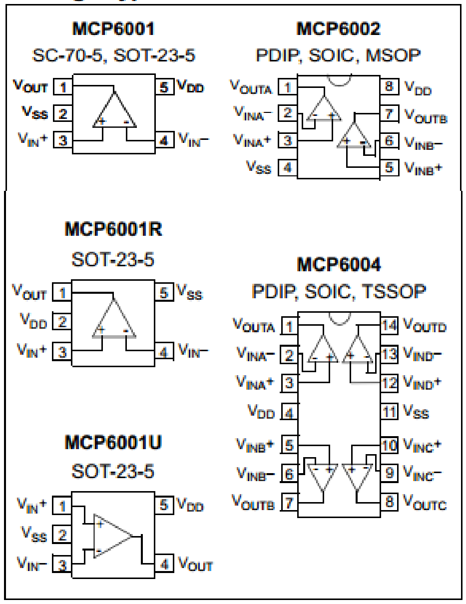
Non-Inverting Amplifier

Description

The Microchip Technology Inc. MCP6001/2/4 family of operational amplifiers (op amps) is specifically designed for general-purpose applications. This family has a 1 MHz Gain Bandwidth Product (GBWP) and 90° phase margin (typical). It also maintains 45° phase margin (typical) with a 500 pF capacitive load. This family operates from a single supply voltage as low as 1.8V, while drawing 100 µA (typical) quiescent current. Additionally, the MCP6001/2/4 supports rail-to-rail input and output swing, with a common mode input voltage range of V_{DD} + 300 mV to V_{SS} – 300 mV. This family of op amps is designed with Microchip's advanced CMOS process.

The MCP6001/2/4 family is available in the industrial and extended temperature ranges, with a power supply range of 1.8V to 6.0V.

Package Types



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

$V_{DD} - V_{SS}$ 7.0V

Current at Analog Input Pins ($V_{IN}+$, $V_{IN}-$).....................±2 mA

Analog Inputs ($V_{IN}+$, $V_{IN}-$) †† .... V_{SS} – 1.0V to V_{DD} + 1.0V

All Other Inputs and Outputs .... V_{SS} – 0.3V to V_{DD} + 0.3V

Difference Input Voltage .... $|V_{DD} - V_{SS}|$

Output Short Circuit Current ....Continuous

Current at Output and Supply Pins ....±30 mA

Storage Temperature....................................–65°C to +150°C

Maximum Junction Temperature (T_J)..........................+150°C

ESD Protection On All Pins (HBM; MM)............. ≥ 4 kV; 200V

† Notice: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

†† See **Section 4.1.2 "Input Voltage and Current Limits"**.

DC ELECTRICAL SPECIFICATIONS

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C, V_{DD} = +1.8V to +5.5V, V_{SS} = GND, $V_{CM} = V_{DD}/2$, $V_L = V_{DD}/2$, R_L = 10 kΩ to V_L, and $V_{OUT} \approx V_{DD}/2$ (refer to Figure 1-1 and Figure 1-2).

Parameters	Sym	Min	Typ	Max	Units	Conditions
Input Offset						
Input Offset Voltage	V_{OS}	-4.5	—	+4.5	mV	$V_{CM} = V_{SS}$ **(Note 1)**
Input Offset Drift with Temperature	$\Delta V_{OS}/\Delta T_A$	—	±2.0	—	µV/°C	T_A= -40°C to +125°C, $V_{CM} = V_{SS}$
Power Supply Rejection Ratio	PSRR	—	86	—	dB	$V_{CM} = V_{SS}$
Input Bias Current and Impedance						
Input Bias Current:	I_B	—	±1.0	—	pA	
Industrial Temperature	I_B	—	19	—	pA	T_A = +85°C
Extended Temperature	I_B	—	1100	—	pA	T_A = +125°C
Input Offset Current	I_{OS}	—	±1.0	—	pA	
Common Mode Input Impedance	Z_{CM}	—	10^{13}||6	—	Ω||pF	
Differential Input Impedance	Z_{DIFF}	—	10^{13}||3	—	Ω||pF	
Common Mode						
Common Mode Input Range	V_{CMR}	V_{SS} – 0.3	—	V_{DD} + 0.3	V	
Common Mode Rejection Ratio	CMRR	60	76	—	dB	V_{CM} = -0.3V to 5.3V, V_{DD} = 5V
Open-Loop Gain						
DC Open-Loop Gain (Large Signal)	A_{OL}	88	112	—	dB	V_{OUT} = 0.3V to V_{DD} – 0.3V, $V_{CM} = V_{SS}$
Output						
Maximum Output Voltage Swing	V_{OL}, V_{OH}	V_{SS} + 25	—	V_{DD} – 25	mV	V_{DD} = 5.5V, 0.5V Input Overdrive
Output Short Circuit Current	I_{SC}	—	±6	—	mA	V_{DD} = 1.8V
		—	±23	—	mA	V_{DD} = 5.5V
Power Supply						
Supply Voltage	V_{DD}	1.8	—	6.0	V	**Note 2**
Quiescent Current per Amplifier	I_Q	50	100	170	µA	I_O = 0, V_{DD} = 5.5V, V_{CM} = 5V

Note 1: MCP6001/1R/1U/2/4 parts with date codes prior to December 2004 (week code 49) were tested to ±7 mV minimum/maximum limits.

2: All parts with date codes November 2007 and later have been screened to ensure operation at V_{DD} = 6.0V. However, the other minimum and maximum specifications are measured at 1.8V and 5.5V.

AC ELECTRICAL SPECIFICATIONS

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C, V_{DD} = +1.8 to 5.5V, V_{SS} = GND, V_{CM} = $V_{DD}/2$, V_L = $V_{DD}/2$, $V_{OUT} \approx V_{DD}/2$, R_L = 10 kΩ to V_L, and C_L = 60 pF (refer to Figure 1-1 and Figure 1-2).						
Parameters	**Sym**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
AC Response						
Gain Bandwidth Product	GBWP	—	1.0	—	MHz	
Phase Margin	PM	—	90	—	°	G = +1 V/V
Slew Rate	SR	—	0.6	—	V/µs	
Noise						
Input Noise Voltage	E_{ni}	—	6.1	—	µVp-p	f = 0.1 Hz to 10 Hz
Input Noise Voltage Density	e_{ni}	—	28	—	nV/√Hz	f = 1 kHz
Input Noise Current Density	i_{ni}	—	0.6	—	fA/√Hz	f = 1 kHz

TEMPERATURE SPECIFICATIONS

Electrical Characteristics: Unless otherwise indicated, V_{DD} = +1.8V to +5.5V and V_{SS} = GND.						
Parameters	**Sym**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
Temperature Ranges						
Industrial Temperature Range	T_A	-40	—	+85	°C	
Extended Temperature Range	T_A	-40	—	+125	°C	
Operating Temperature Range	T_A	-40	—	+125	°C	**Note**
Storage Temperature Range	T_A	-65	—	+150	°C	
Thermal Package Resistances						
Thermal Resistance, 5L-SC70	θ_{JA}	—	331	—	°C/W	
Thermal Resistance, 5L-SOT-23	θ_{JA}	—	256	—	°C/W	
Thermal Resistance, 8L-PDIP	θ_{JA}	—	85	—	°C/W	
Thermal Resistance, 8L-SOIC (150 mil)	θ_{JA}	—	163	—	°C/W	
Thermal Resistance, 8L-MSOP	θ_{JA}	—	206	—	°C/W	
Thermal Resistance, 14L-PDIP	θ_{JA}	—	70	—	°C/W	
Thermal Resistance, 14L-SOIC	θ_{JA}	—	120	—	°C/W	
Thermal Resistance, 14L-TSSOP	θ_{JA}	—	100	—	°C/W	

Note: The industrial temperature devices operate over this extended temperature range, but with reduced performance. In any case, the internal Junction Temperature (T_J) must not exceed the Absolute Maximum specification of +150°C.

1.1 Test Circuits

The test circuits used for the DC and AC tests are shown in Figure 1-1 and Figure 1-2. The bypass capacitors are laid out according to the rules discussed in **Section 4.4 "Supply Bypass"**.

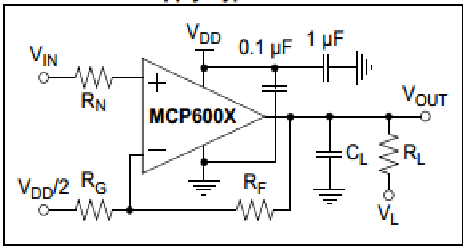


FIGURE 1-1: *AC and DC Test Circuit for Most Non-Inverting Gain Conditions.*

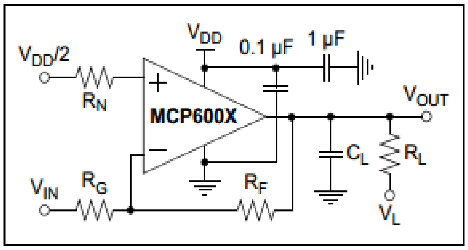


FIGURE 1-2: *AC and DC Test Circuit for Most Inverting Gain Conditions.*

3.0 PIN DESCRIPTIONS

Descriptions of the pins are listed in Table 3-1.

TABLE 3-1: PIN FUNCTION TABLE

MCP6001	MCP6001R	MCP6001U	MCP6002	MCP6004	Symbol	Description
SC-70-5, SOT-23-5	SOT-23-5	SOT-23-5	MSOP, PDIP, SOIC	PDIP, SOIC, TSSOP		
1	1	4	1	1	V_{OUT}, V_{OUTA}	Analog Output (op amp A)
4	4	3	2	2	$V_{IN}-$, $V_{INA}-$	Inverting Input (op amp A)
3	3	1	3	3	$V_{IN}+$, $V_{INA}+$	Non-inverting Input (op amp A)
5	2	5	8	4	V_{DD}	Positive Power Supply
—	—	—	5	5	$V_{INB}+$	Non-inverting Input (op amp B)
—	—	—	6	6	$V_{INB}-$	Inverting Input (op amp B)
—	—	—	7	7	V_{OUTB}	Analog Output (op amp B)
—	—	—	—	8	V_{OUTC}	Analog Output (op amp C)
—	—	—	—	9	$V_{INC}-$	Inverting Input (op amp C)
—	—	—	—	10	$V_{INC}+$	Non-inverting Input (op amp C)
2	5	2	4	11	V_{SS}	Negative Power Supply
—	—	—	—	12	$V_{IND}+$	Non-inverting Input (op amp D)
—	—	—	—	13	$V_{IND}-$	Inverting Input (op amp D)
—	—	—	—	14	V_{OUTD}	Analog Output (op amp D)

3.1 Analog Outputs

The output pins are low-impedance voltage sources.

3.2 Analog Inputs

The non-inverting and inverting inputs are high-impedance CMOS inputs with low bias currents.

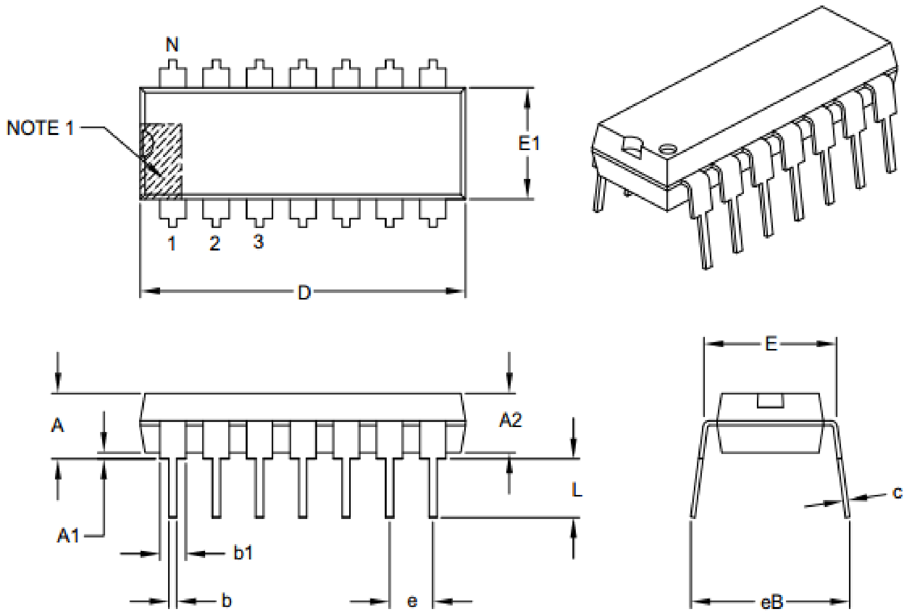
3.3 Power Supply Pins

The positive power supply (V_{DD}) is 1.8V to 6.0V higher than the negative power supply (V_{SS}). For normal operation, the other pins are at voltages between V_{SS} and V_{DD}.

Typically, these parts are used in a single (positive) supply configuration. In this case, V_{SS} is connected to ground and V_{DD} is connected to the supply. V_{DD} will need bypass capacitors.

14-Lead Plastic Dual In-Line (P) – 300 mil Body [PDIP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



	Units	INCHES		
	Dimension Limits	MIN	NOM	MAX
Number of Pins	N		14	
Pitch	e		.100 BSC	
Top to Seating Plane	A	–	–	.210
Molded Package Thickness	A2	.115	.130	.195
Base to Seating Plane	A1	.015	–	–
Shoulder to Shoulder Width	E	.290	.310	.325
Molded Package Width	E1	.240	.250	.280
Overall Length	D	.735	.750	.775
Tip to Seating Plane	L	.115	.130	.150
Lead Thickness	c	.008	.010	.015
Upper Lead Width	b1	.045	.060	.070
Lower Lead Width	b	.014	.018	.022
Overall Row Spacing §	eB	–	–	.430

Notes:

1. Pin 1 visual index feature may vary, but must be located with the hatched area.
2. § Significant Characteristic.
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" per side.
4. Dimensioning and tolerancing per ASME Y14.5M.

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-005B

Anexo G

Hoja de Dato del ABSplus – P430

ABS*plus*™-P430

Production-Grade Thermoplastic
for Dimension 3D Printers

ABS*plus* is a true production-grade thermoplastic that is durable enough to perform virtually the same as production parts. When combined with Dimension 3D Printers, ABS*plus* is the ideal solution to printing 3D models in an office environment.

Mechanical Properties[1]	Test Method	English	Metric
Tensile Strength (Type 1, 0.125", 0.2"/min)	ASTM D638	5,300 psi	37 MPa
Tensile Modulus (Type 1, 0.125", 0.2"/min)	ASTM D638	330,000 psi	2,320 MPa
Tensile Elongation (Type 1, 0.125", 0.2"/min)	ASTM D638	3%	3%
Flexural Delamination	ASTM D790	4,500 psi	31 MPa
Flexural Strength (Method 1, 0.05"/min)	ASTM D790	7,600 psi	53 MPa
Flexural Modulus (Method 1, 0.05"/min)	ASTM D790	320,000 psi	2,250 MPa
IZOD Impact, notched (Method A, 23°C)	ASTM D256	2.0 ft-lb/in	106 J/m

Thermal Properties[2]	Test Method	English	Metric
Heat Deflection (HDT) @ 66 psi	ASTM D648	204°F	96°C
Heat Deflection (HDT) @ 264 psi	ASTM D648	180°F	82°C
Glass Transition Temperature (Tg)	DMA (SSYS)	226°F	108°C
Melt Point	- - - - - - - - -	Not Applicable[3]	Not Applicable[3]
Coefficient of Thermal Expansion	ASTM E831	4.90E-05 in/in/°F	- - - - - - - - -

Electrical Properties[4]	Test Method	Value Range
Volume Resistivity	ASTM D257	3.0x10e14 - 6.0x10e13 ohms
Dielectric Constant	ASTM D150-98	2.9 - 2.6
Dissipation Factor	ASTM D150-98	.0053 - .0046
Dielectric Strength	ASTM D149-09, Method A	320 - 100 V/mm
Dielectric Strength	IEC 60112	28.0 kV/mm

Stratasys | Design Series

ABSplus™-P430

Other[2]	Test Method	Value
Specific Gravity	ASTM D792	1.04
Flame Classification	UL94	HB (0.09", 2.50mm)
UL File Number	- - - - - - - - -	E345258

System Availability	Layer Thickness Capability	Support Structure	Available Colors
uPrint SE uPrint SE Plus Dimension Elite Dimension SST 1200es Dimension BST 1200es	0.013 inch (0.330 mm) 0.010 inch (0.254 mm) 0.007 inch (0.178 mm)[5]	Soluble Supports Breakaway Supports (BST 1200es only)	Ivory[6] White Black Dark Grey Red Blue Olive Green Nectarine Fluorescent Yellow

The information presented are typical values intended for reference and comparison purposes only. They should not be used for design specifications or quality control purposes. End-use material performance can be impacted (+/-) by, but not limited to, part design, end-use conditions, test conditions, color etc. Actual values will vary with build conditions. Product specifications are subject to change without notice.

The performance characteristics of these materials may vary according to application, operating conditions, or end use. Each user is responsible for determining that the Stratasys material is safe, lawful, and technically suitable for the intended application, as well as for identifying the proper disposal (or recycling) method consistent with applicable environmental laws and regulations. Stratasys makes no warranties of any kind, express or implied, including, but not limited to, the warranties of merchantability, fitness for a particular use, or warranty against patent infringement.

[1]Build orientation is on side long edge. [2]Literature value unless otherwise noted. [3]Due to amorphous nature, material does not display a melting point. [4]All Electrical Property values were generated from the average of test plaques built with default part density (sparse). Test plaques were 4.0 x 4.0 x 0.1 inches (102 x 102 x 2.5 mm) and were built both in the flat and vertical orientation. The range of values is mostly the result of the difference in properties of test plaques built in the flat vs. vertical orientation. [5]0.007 inch (0.178 mm) layer thickness available on Dimension Elite only. [6]Ivory is the only color option for uPrint.

Stratasys | www.stratasys.com | info@stratasys.com

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Eden Prairie, MN 55344
+1 888 480-3548 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

2 Holtzman St.,
Science Park, PO Box 2496
Rehovot 76124, Israel
+972 74 745-4000
+972 74 745-5000 (Fax)

Local Street Address
City, State, Zip
Phone #
Fax #

Stratasys® | Design Series

Anexo H

Hojas de Datos de engranajes

Los engranajes que se escogieron para accionar los dedos de la prótesis de mano son:

- Engranajes cónicos son de latón, poseen 24 dientes, 32 de paso y 5mm diámetro interno.
- Engranajes rectos deben cumplir con una distancia de centros de 0.75 pulgadas, 32 de paso y sumatoria total de dientes (engranaje conductor + engranaje conducido) igual a 48;

Estos requerimientos se encuentran en las siguientes hojas de datos:

Engranajes cónicos distribuidos por la compañía Actobotics:

Actobotics™ DREAM. DESIGN. BUILD. REPEAT.

Now you can build right angle drives inside or outside of channel with these new 24 tooth, 32 pitch bevel gears. We offer them in four bore sizes, 1/4", 4mm, 5mm and 6mm. Great for building differentials or any application where you need to transfer rotational motion 90 degrees. Sold individually with set-screw.


Fig. 1


Fig. 2


Fig. 3

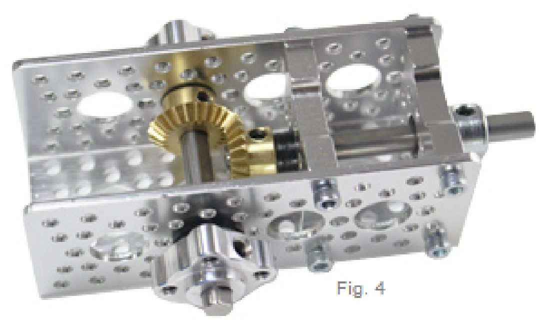


Fig. 4

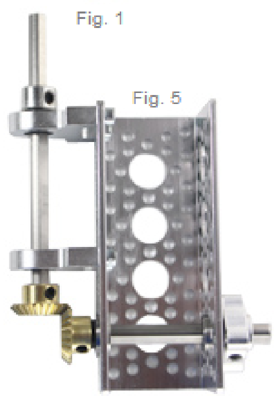
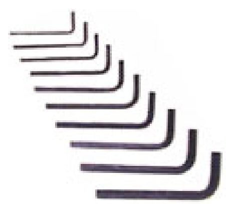


Fig. 5



The set screw requires a 3/32" Hex Key (sold separately).

Video

Click Here to watch the bevel gears in action!

Share these gears with friends!

17

Teeth	Part #	Bore	Weight	Price	Status	Qty	Buy
24T	615398	1/4"	.35 oz.	$5.99	In-Stock	1	Add to Cart
24T	615402	4mm	.35 oz.	$5.99	Coming soon!	1	
24T	615404	5mm	.35 oz.	$5.99	Coming soon!	1	
24T	615406	6mm	.35 oz.	$5.99	Coming soon!	1	

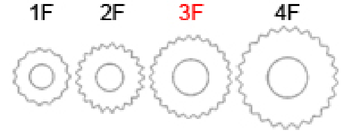
Engranajes rectos fabricados por la compañía Futuba:

Finally a way to drive gears using servos! Our patented 32 pitch Futaba metal gears are designed to attach directly to the output spline of a servo. All gears are broached directly into the metal to ensure a snug fit that will not slip. These gears are designed to fit the standard 25 tooth Futaba output spline.

Futaba PATENTED

Spline = Futaba 25T Spline
Width = 1/4" (.250")
Pressure Angle = 20°

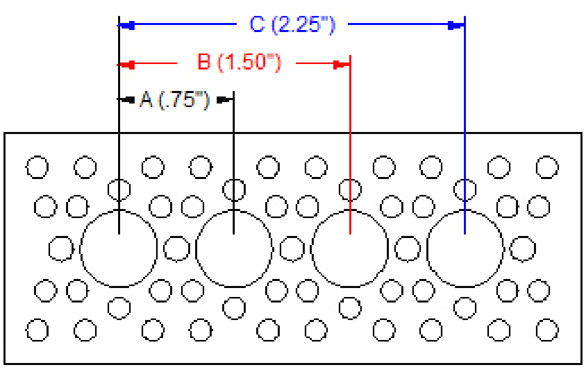
Uses a 3F Standard Spline (25T)



Share these gears with friends! 5

Click for more information

GEAR MESH INFORMATION:



Center-Center Distance	Total Tooth Count (32 Pitch)
A (0.75")	48
B (1.5")	96
C (2.25")	144

FTC APPROVED
Click here for more FTC approved items

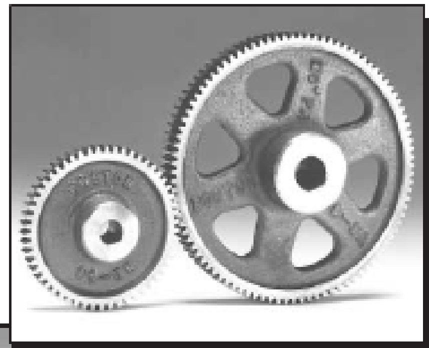
Example: Using distance B (1.5") with 32P gears
Total tooth count (pinion gear + spur gear) must equal 96
For an application that requires a 3:1 ratio:
24T pinion gear + 72T spur gear = 96 total tooth count
72 ÷ 24 = 3 (3:1 ratio)

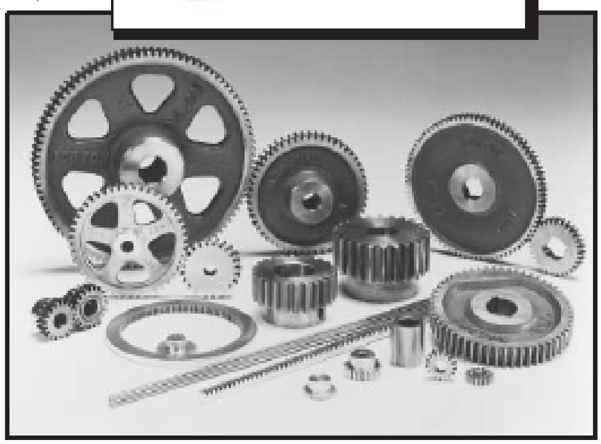
Tooth	Part #	P.D.	O.D.	Price	Status	Qty	Buy
16	**615298**	.500"	.563"	$14.99	In-Stock	1	Add to Cart
20	**615302**	.625"	.688"	$14.99	In-Stock	1	Add to Cart

Engranajes rectos fabricados por la compañía Boston Gear:

SPUR GEARS

- Parallel Shaft Applications
- Reliability from Steel, Cast Iron and Brass
- More Cost Effective, Quieter Running and Corrosion-Resistant Operation from Non-Metallic Options
- Higher Load Carrying Capacity with 20° PA (Pressure Angle)
- Higher Contact Ratio for a Smoother, Quieter Operation with 14-1/2° PA





Selections From Stock

- Pinions and Gears (Steel, Cast Iron, Brass, Non-Metallic)
- Change Gears (Steel or Cast Iron)
- Stem Pinions (Steel)
- Drawn Pinion Wire (Brass, Steel)
- Rack (Brass, Steel, Nylon)
- Internal (Brass)
- Diametral Pitch 64 DP to 3 DP
- Pitch Diameter .208" to 36.000"
- Diametral Pitch System Standardized on Stock Gears
- 14-1/2° and 20° Pressure Angles

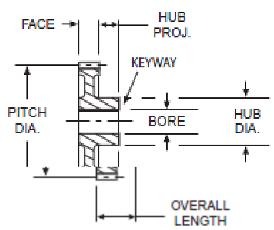
Boston spur gears are designed to transmit motion and power between parallel shafts. Configurations include spur, rack, pinion wire, stem pinions and internal gears; most with a selection of bores, keyways and set screws. Fine-pitch gears are available in plastic, brass, stainless steel and steel. Heavier pitch spurs are available in steel and cast iron. Styles include plain, web, web with lightening holes or spoked. Change gears have consecutive numbers of teeth for a variety of ratios.

Boston Gear manufactures both 14-1/2° and 20° PA, involute, full depth system gears. While 20° PA is generally recognized as having higher load carrying capacity, 14-1/2° PA gears have extensive use. The lower pressure angle results in less change in backlash due to center distance variation and concentricity errors. It also provides a higher contact ratio and is consequently a smoother, quieter operation provided that the undercut of the teeth is not present.

SPUR GEARS

20 AND 16 DIAMETRAL PITCH
CAST IRON, BRASS AND STEEL

$14^1/_2$° PRESSURE ANGLE
(Will not operate with 20° spurs)



ALL DIMENSIONS IN INCHES
ORDER BY CATALOG NUMBER OR ITEM CODE

No. of Teeth	Pitch Dia.	Bore	Hub Dia.	Hub Proj.	Style See Page 150	Without Keyway or Setscrew Catalog Number	Without Keyway or Setscrew Item Code	With Keyway and Setscrew† Catalog Number	With Keyway and Setscrew† Item Code
20 DIAMETRAL PITCH						Face = .375" Outside Dia. = Pitch Dia. + .100" Overall Length = .375" + Hub Proj.			
CAST IRON									
70	3.500	.375	1.25	.50	B	NA70	10216	–	–
72	3.600					NA72	10218	–	–
80	4.000	.500	1.25	.50		NA80	10220	–	–
84	4.200					NA84	10222	–	–
90	4.500				C	NA90	10224	–	–
96	4.800					NA96	10226	–	–
100	5.000				D	NA100	10228	–	–
112	5.600	.500	1.50	.50		NA112	10230	–	–
120	6.000					NA120	10232	–	–
140	7.000					NA140	10234	–	–
144	7.200					NA144	10236	–	–
160	8.000			.62		NA160	10238	–	–
180	9.000					NA180	10240	–	–
200	10.000		1.75			NA200B	10242	–	–
16 DIAMETRAL PITCH						Face = .313" Outside Dia. = Pitch Dia. + .125" Overall Length = Face + Hub Proj.			
BRASS									
8	.500	.1875	–	–	A	G226	09168	–	–
9	.563					G227	09170	–	–
10	.625	.250	–	–		G228	09172	–	–
12	.750					G229	09174	–	–
14	.875					G230	09176	–	–
16	1.000					G231	09178	–	–
18	1.125					G232	09180	–	–
20	1.250					G233	09182	–	–
24	1.500	.3125	–	–		G235	09184	–	–
28	1.750		–	–		G236	09186	–	–
32	2.000	.3125	.75	.31	B	G237	09188	–	–
40	2.500				D	G238	09190	–	–
48	3.000					G239	09192	–	–
56	3.500	.375	.88	.38		G240	09194	–	–
64	4.000		1.00			G241	09196	–	–
80	5.000		1.00			G242	09198	–	–
STEEL Face = .500"									
11	.750*	.375	.56	.44	A	NB11B	09704	NB11B-3/8†	46029
12	.750		.56			NB12B	09706	NB12B-3/8†	46030
13	.813		.63			NB13B	09708	NB13B-3/8†	46031
14	.875		.69			NB14B	09710	NB14B-3/8†	46032
15	.938	.500	.75	.44		NB15B	09712	NB15B-1/2†	46033
16	1.000		.81			NB16B	09714	NB16B-1/2†	46034
18	1.125		.94			NB18B	09716	NB18B-1/2†	46035
20	1.250	.500	.96	.44		NB20B	09718	NB20B-1/2†	46036
		.625				–	–	NB20B-5/8	46037
22	1.375	.500	1.08	.44		NB22B	09720	NB22B-1/2†	46038
		.625				–	–	NB22B-5/8	46039
24	1.500	.500	1.20	.44		NB24B	09722	NB24B-1/2†	46040
		.625				–	–	NB24B-5/8	46041
		.750				–	–	NB24B-3/4	46042
26	1.625	.500	1.33	.44		NB26B	09724	NB26B-1/2†	46043
		.625				–	–	NB26B-5/8	46044
		.750				–	–	NB26B-3/4	40645
28	1.750	.500	1.45	.50		NB28B	09726	NB28B-1/2†	46046
		.625				–	–	NB28B-5/8	46047
		.750				–	–	NB28B-3/4	46048
		.875				–	–	NB28B-7/8	46049
30	1.875	.500	1.58	.50		NB30B	09728	NB30B-1/2†	46050
		.625				–	–	NB30B-5/8	46051
		.750				–	–	NB30B-3/4	46052
		.875				–	–	NB30B-7/8	46053
		1.000				–	–	NB30B-1	46054

(continued next page)

STANDARD TOLERANCES

DIMENSION		TOLERANCE
BORE	All	±.0005
HUB DIA.	All	±1/32

20 D.P.   16 D.P.

REFERENCE PAGES

Alterations — 149
Horsepower Ratings — 39, 40
Lubrication — 149
Materials — 150
Selection Procedure — 37

*Special Pitch Diameter, used for calculating Center Distance only, not Ratio.

†3/8" and 1/2" bores have one setscrew, no keyway.

5/8" bore and larger have standard keyway at 90° to setscrew. See Page 150.

BOSTON GEAR®

Anexo I
Cotizaciones

Impresión de piezas en 3D

D3SARROLLO 3D
Building your imagination

DESARROLLO 3D PERU SAC
RUC: 20554212850

DATOS DEL CLIENTE:

FECHA: 01.07.14
RAZÓN SOCIAL: Carlos Salas
N° DE RUC:
SOLICITANTE:
E-mail:
TELÉFONO: 944210914
PRECIO POR CM3: US$ 3.50 Inc. IGV

N° DE COTIZACIÓN: 014-D3D26

De nuestra consideración: Hacemos llegar nuestra cotización por impresión en 3D de acuerdo a sus requerimientos

ITEM	DESCRIPCION DE PRODUCTO	CANT.	MATERIAL EN CM3	PRECIO TOTAL (INC.IGV)
1	Prototipo tapa	1	19.96	69.86
2	accesorio acople	4	5.13	17.96
3	Acople	1	84.02	294.07
4	Distal	3	3.98	41.82
5	Palma base 1	1	72.23	252.81
6	Palma base 2	1	21.16	74.06
7	Pieza 1	6	0.79	16.62
8	Pieza 2	6	0.82	17.16
			VALOR VENTA	341.08
			IGV	61.39
			TOTAL A PAGAR	402.47

CONDICIONES COMERCIALES	
FORMA DE PAGO	50% ADELANTADO,SALDO CONTRA ENTREGA
TIEMPO DE ENTREGA	4 DÍAS POSTERIORES A LA ORDEN DE SERVICIO.
LOS TRABAJOS SE INICIAN PREVIOS DEPÓSITOS A LA CTA MENCIONADAS LÍNEAS ABAJO	

DATOS DE LA EMPRESA		
CTA CTE DÓLARES:	194-2063111-1-14	Banco de Crédito BCP ViaBCP
CTA CTE SOLES:	194-2086899-0-85	

Construyendo tu Imaginación

Imprime con los profesionales
www.desarrollo3d.com

Desarrollo 3D Perú SAC
Teléfono: 51-1-2213692
Calle José Toribio Polo N° 270-Miraflores
LIMA 18

D3SARROLLO 3D
Building your imagination

DESARROLLO 3D PERU SAC
RUC: 20554212850

DATOS DEL CLIENTE:

FECHA: 01.07.14
RAZÓN SOCIAL: Carlos Salas
N° DE RUC:
SOLICITANTE:
E-mail:
TELÉFONO: 944210914
PRECIO POR CM3: US$ 3.50 Incl. IGV

N° DE COTIZACIÓN: 014-D3D27

De nuestra consideración: Hacemos llegar nuestra cotización por impresión en 3D de acuerdo a sus requerimientos

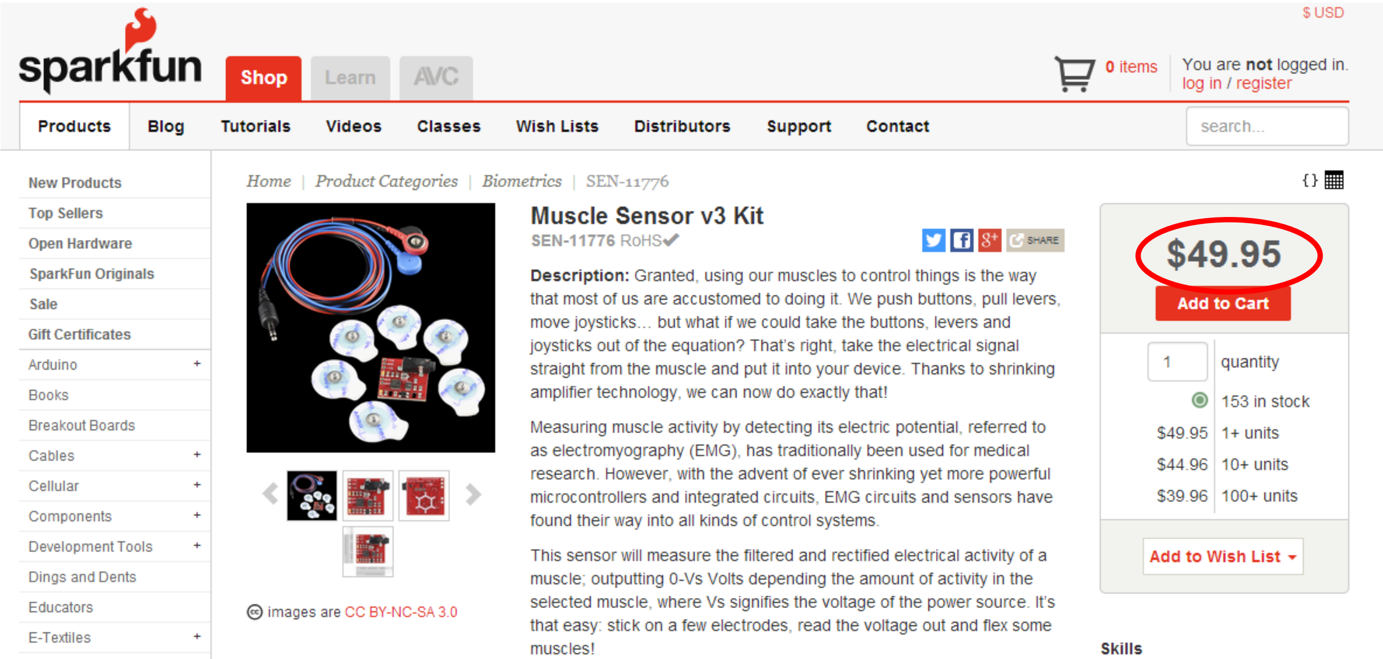
ITEM	DESCRIPCION DE PRODUCTO	CANT.	MATERIAL EN CM3	PRECIO TOTAL (INC.IGV)
1	Pieza 4	3	0.75	7.83
2	Pieza 5	3	1.10	11.55
3	Pieza 6	3	1.06	11.13
4	Proximal	3	3.92	41.12
			VALOR VENTA	60.70
			IGV	10.93
			TOTAL A PAGAR	**71.63**

CONDICIONES COMERCIALES	
FORMA DE PAGO	50% ADELANTADO,SALDO CONTRA ENTREGA
TIEMPO DE ENTREGA	4 DIAS POSTERIORES A LA ORDEN DE SERVICIO.
LOS TRABAJOS SE INICIAN PREVIOS DEPÓSITOS A LA CTA MENCIONADAS LÍNEAS ABAJO	

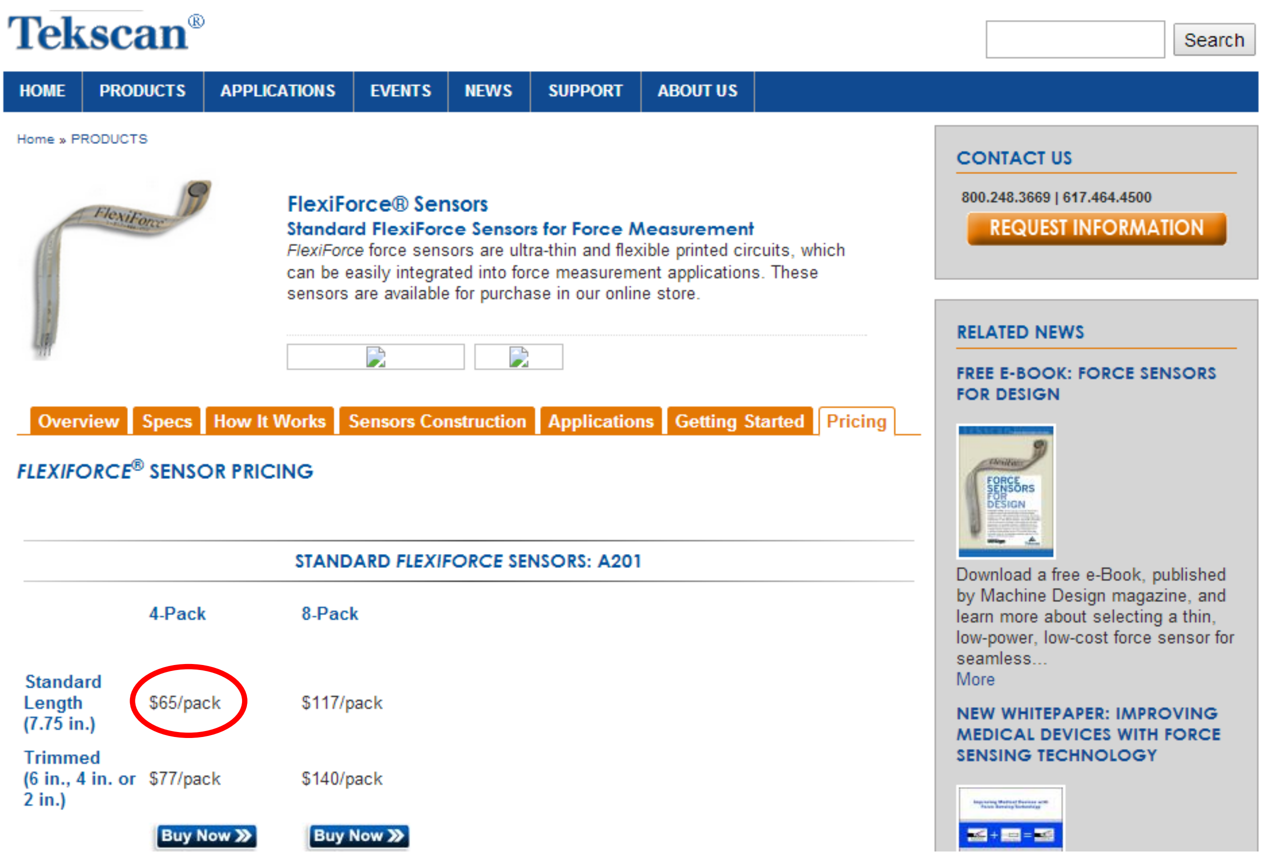
DATOS DE LA EMPRESA		
CTA CTE DÓLARES:	194-2063111-1-14	Banco de Crédito BCP ViaBCP
CTA CTE SOLES:	194-2086899-0-85	

Construyendo tu Imaginación

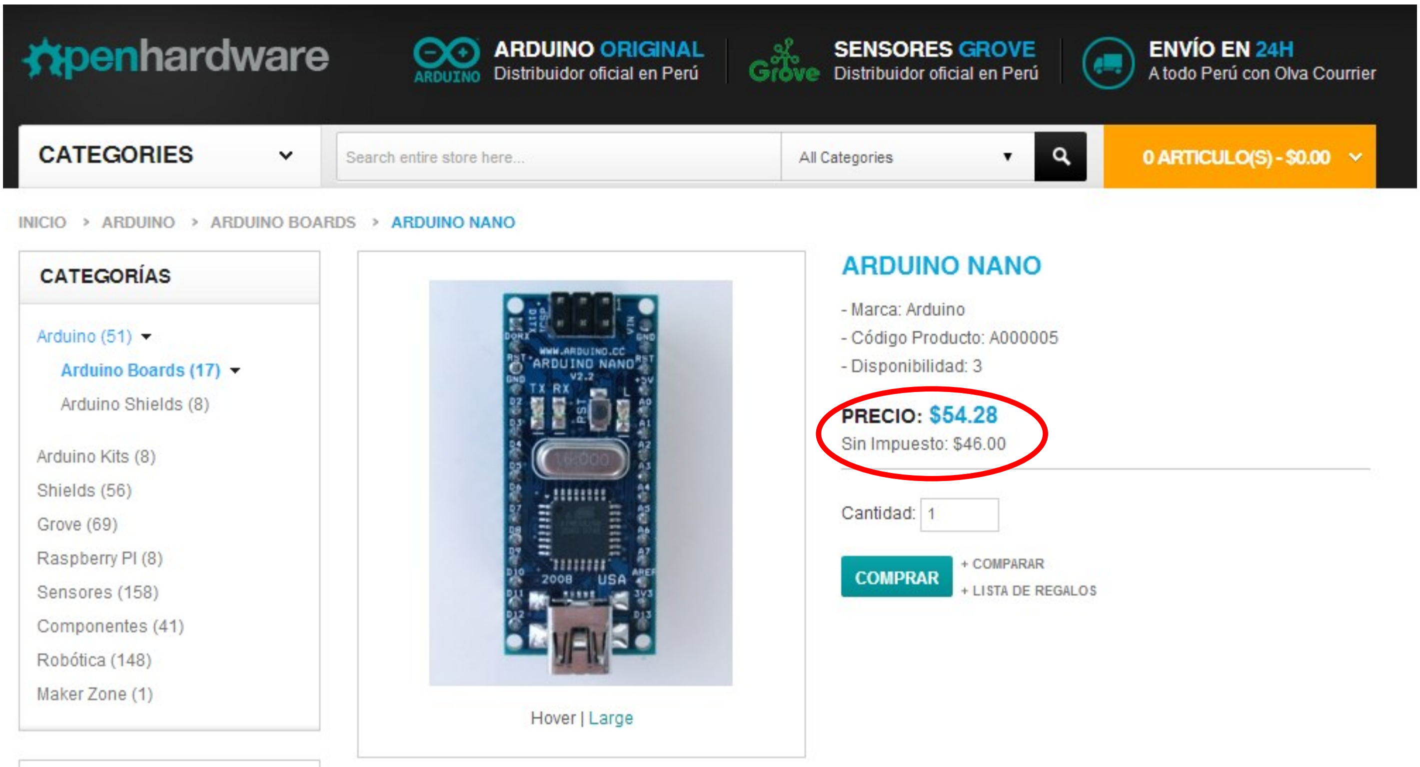
Sensor de músculo



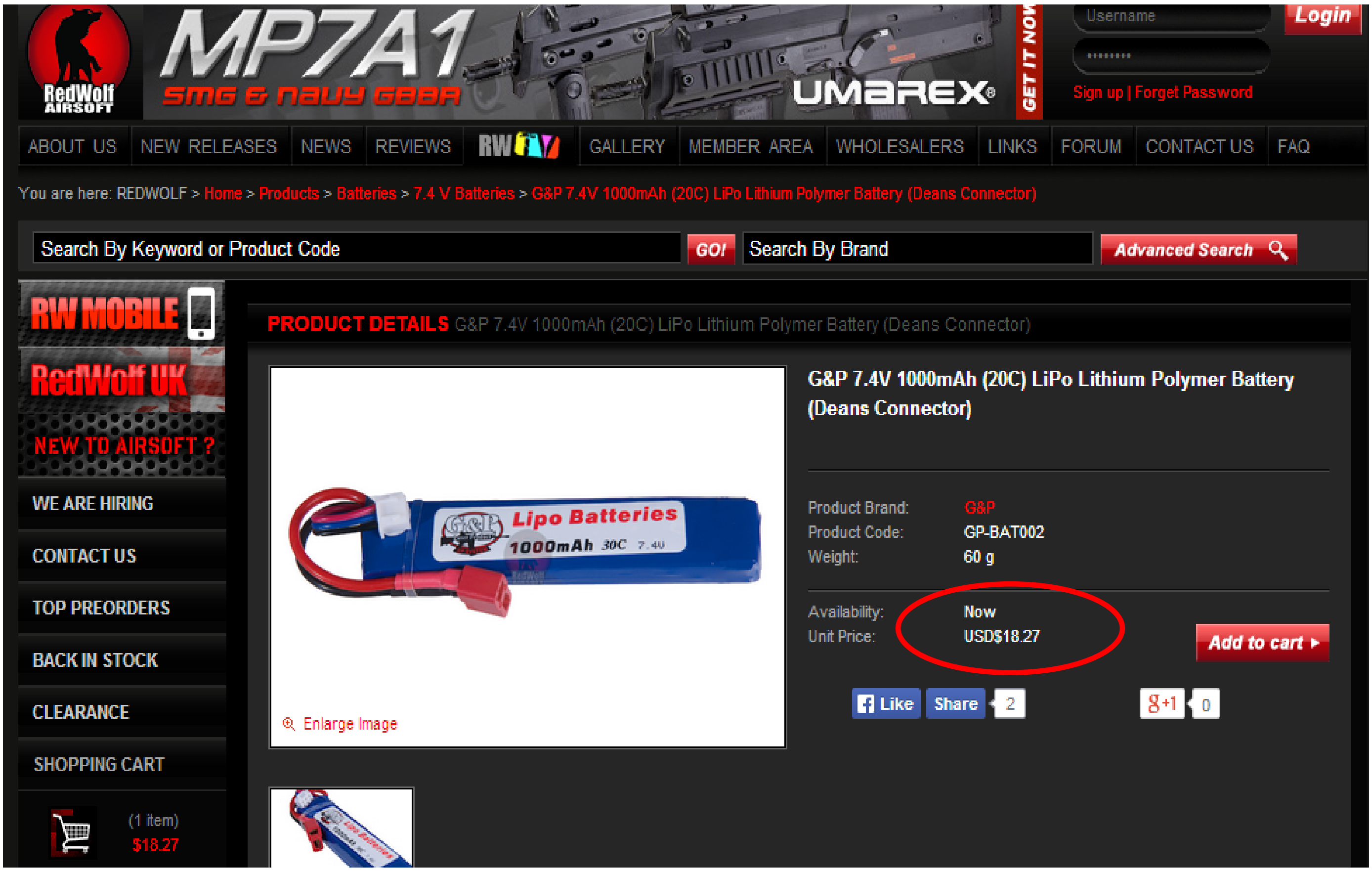
Sensor de fuerza flexiforce



Arduino Nano 3.0



Batería de Litio polímero



Servomotor con engranajes metálicos

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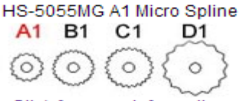
Newsletter Sign-up

MAXIMUM TORQUE 22.2 oz-in. **MAXIMUM SPEED** 0.17 sec/60°

Introducing the all new HS-5055MG Metal Gear Feather Servo. Tired of having your sub-micro servos strip gears? The HS-5055Mg is the solution! Not only does this servo have super-strong metal gears but it also incorporates the latest in digital technology. Along with a Hitec programmer, you can change a number of performance characteristics of the HS-5055MG. We offer the new HS-5055MG servo in several configurations, 90° stock rotation, 120° modified rotation (programmed), and reverse rotation.

*Digital servos do not need to be programmed to operate. They work great right out of the box and purchasing a programmer is not necessary.

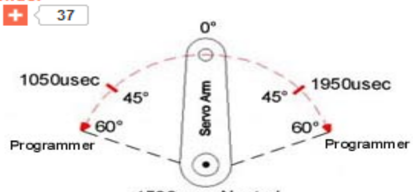
HS-5055MG A1 Micro Spline



Click for more information

Share with friends! 37

Price: $17.99
Part: 35055S
Status: In-Stock
Rotation: 90° Rotation (Stock)
Direction: Clockwise (Stock)
Qty: 1 Add to Cart



This servo can be configured to operate 180° by using any of the following servo programmers: Hitec HFP-25, HPP-21, HPP-21+

Digital Servo
Programmable

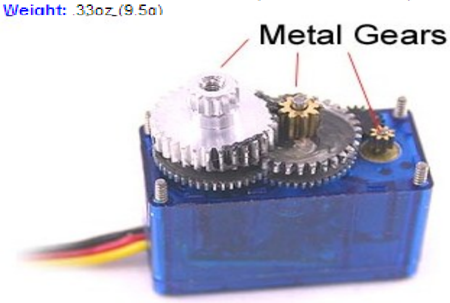
Programable Features:
- Dead Band Width
- Direction of Rotation
- Speed of Rotation (slower)
- End Points (up to 120 degrees)
- Neutral Points
- Fail Safe On/Off
- Fail Safe Points
- Resolution (default is set at high)
- Overload Protection (default is off)

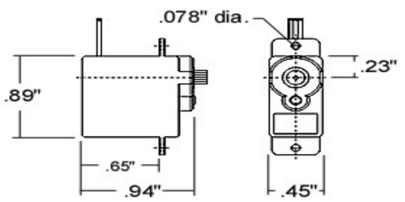
Detailed Specifications

Control System: +Pulse Width Control 1500usec Neutral
Required Pulse: 3-5 Volt Peak to Peak Square Wave
Operating Voltage Range: 4.8-6.0 Volts
Operating Temperature Range: -20° to +60° C (-4°F to +140°F)
Operating Speed (4.8V): 0.20 sec/60° at no load
Operating Speed (6.0V): 0.17 sec/60° at no load
Stall Torque (4.8V): 18.05 oz/in. (1.3kg.cm)
Stall Torque (6.0V): 22.2 oz/in. (1.6kg.cm)
Operating Angle: 45 Deg. one side pulse traveling 400usec
Continuous Rotation Modifiable: No
Direction: Clockwise/Pulse Traveling 1500 to 1900usec
Idle Current Drain (4.8V): 3mA at stop
Idle Current Drain (6.0V): 3mA at stop
Dead Band Width: 2usec
Motor Type: Carbon Brush
Potentiometer Drive: 6 Slider Indirect Drive
Bearing Type: Plastic
Gear Type: Metal Gears
Connector Wire Length: 7" (178mm)
Dimensions: .89" x 0451"x .94" (22.8 x 11.6 x 24mm)
Weight: .33oz (9.5g)

CONVERSION CALCULATORS

GENERAL SERVO INFORMATION
- MORE INFO WHAT IS A SERVO?
- MORE INFO HOW SERVOS WORK
- MORE INFO WHAT SERVO TO USE
- MORE INFO SERVO POWER & SPEED
- MORE INFO ROTATION DIRECTION
- MORE INFO CONNECTOR TYPES
- MORE INFO 180 DEGREE ROTATION
- MORE INFO CONTINUOUS ROTATION





Engranajes cónicos metálicos

Actobotics™ DREAM. DESIGN. BUILD. REPEAT.

Now you can build right angle drives inside or outside of channel with these new 24 tooth, 32 pitch bevel gears. We offer them in four bore sizes, 1/4", 4mm, 5mm and 6mm. Great for building differentials or any application where you need to transfer rotational motion 90 degrees. Sold individually with set-screw.


Fig. 1


Fig. 2


Fig. 3

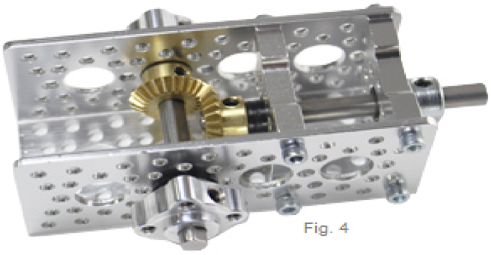


Fig. 4

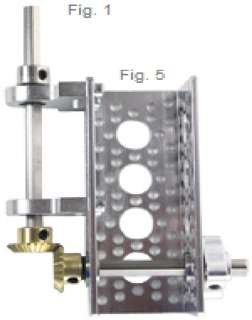


Fig. 5


The set screw requires a 3/32" Hex Key (sold separately).

Video

Click Here to watch the bevel gears in action!

Share these gears with friends! 17

Teeth	Part #	Bore	Weight	Price	Status	Qty	Buy
24T	615398	1/4"	.35 oz.	$5.99	In-Stock	1	Add to Cart
24T	615402	4mm	.35 oz.	$5.99	Coming soon!	1	
24T	615404	5mm	.35 oz.	$5.99	Coming soon!	1	
24T	615406	6mm	.35 oz.	$5.99	Coming soon!	1	

Engranajes rectos metálicos

Actobotics™ DREAM. DESIGN. BUILD. REPEAT.

Finally a way to drive gears using servos! Our patented 32 pitch Futaba metal gears are designed to attach directly to the output spline of a servo. All gears are broached directly into the metal to ensure a snug fit that will not slip. These gears are designed to fit the standard 25 tooth Futaba output spline.

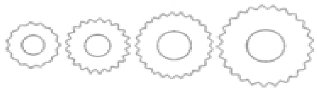
Fig. 1

PATENTED

Futaba

Spline = Futaba 25T Spline
Width = 1/4" (.250")
Pressure Angle = 20°

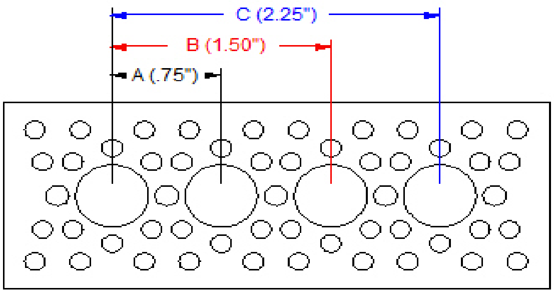
Uses a 3F Standard Spline (25T)



Click for more information

Share these gears with friends! 5

GEAR MESH INFORMATION:



Center-Center Distance	Total Tooth Count (32 Pitch)
A (0.75")	48
B (1.5")	96
C (2.25")	144

FTC APPROVED
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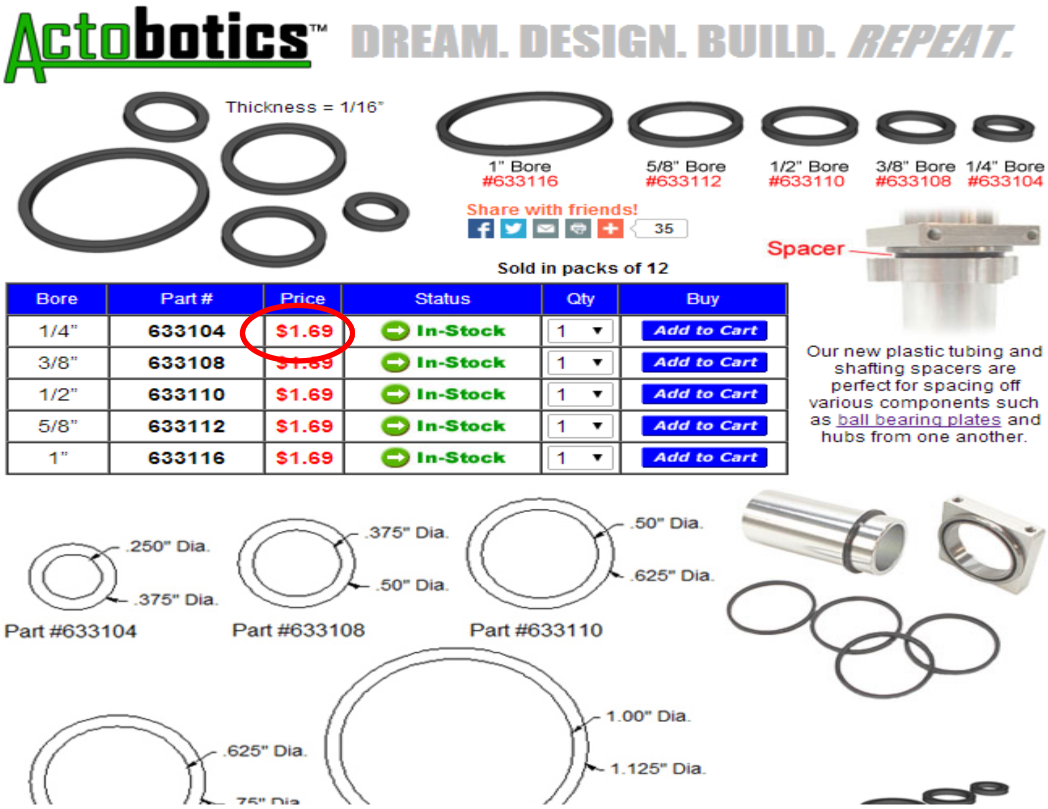
Example: Using distance B (1.5") with 32P gears
Total tooth count (pinion gear + spur gear) must equal 96
For an application that requires a 3:1 ratio:
24T pinion gear + 72T spur gear = 96 total tooth count
72 ÷ 24 = 3 (3:1 ratio)

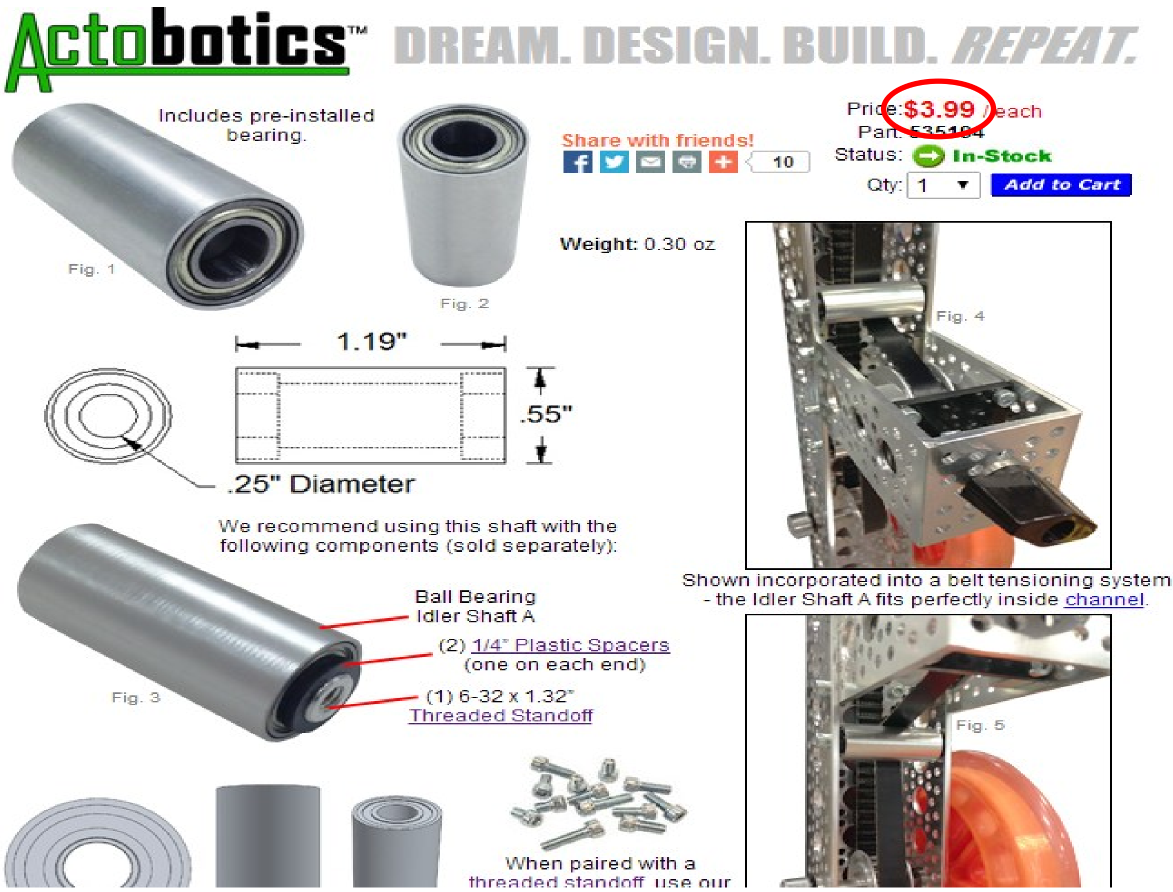
Tooth	Part #	P.D.	O.D.	Price	Status	Qty	Buy
16	615298	.500"	.563"	$14.99	In-Stock	1	Add to Cart
20	615302	.625"	.688"	$14.99	In-Stock	1	Add to Cart

Empaquetaduras



Bore	Part #	Price	Status	Qty	Buy
1/4"	633104	$1.69	In-Stock	1	Add to Cart
3/8"	633108	$1.69	In-Stock	1	Add to Cart
1/2"	633110	$1.69	In-Stock	1	Add to Cart
5/8"	633112	$1.69	In-Stock	1	Add to Cart
1"	633116	$1.69	In-Stock	1	Add to Cart

Pasadores con eje móvil



Tarjeta física de la placa de interconexión entre los sensores de presión y el microcontrolador (cotización vía mail)

Cotización - Quotation   Recibidos x

Carlos Alberto Salas Casapino <carlos.salasc@pucp.pe>
para jobareci

Estimado,

Reciba un cordial saludo.

Quisiera hacer una cotización del siguiente circuito impreso elaborado en fibra de vidrio. Se necesitan 2 placas.

Sin otro particular, me despido a la espera de su respuesta.

Atentamente,

Carlos A. Salas Casapino

Pontificia Universidad Católica del Perú

2 archivos adjuntos

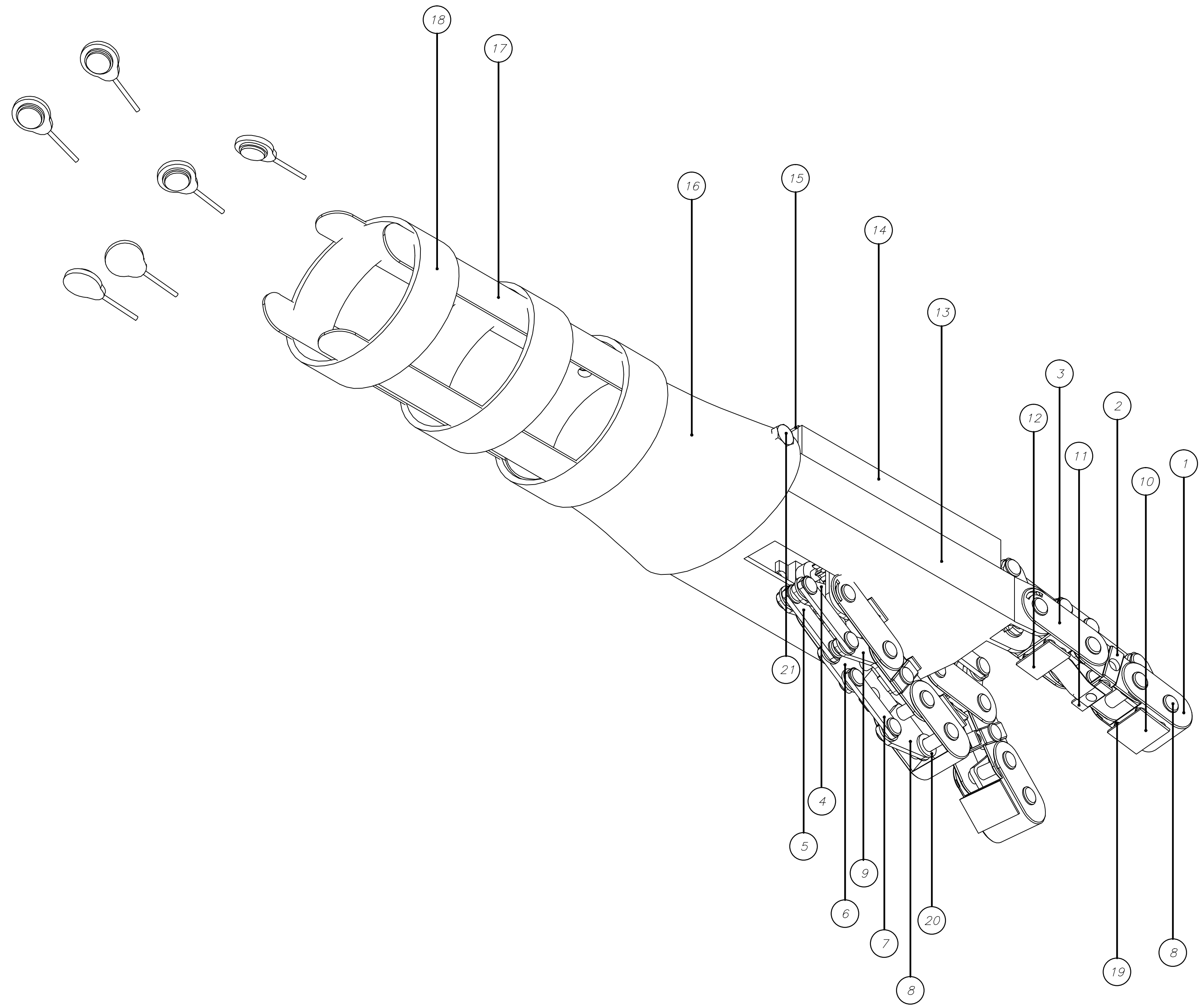
PCB.brd

PCB.sch

JOSE BAZAN REYES   20 de jun. (hace 12 días)
para mí

BUEN DIAS SR. SALAS , EL COSTO DE SUS TARJETAS ES DE 12.00 N SOLES MAS IGV TOTAL SERIA 14.16 N SOLES
FAVOR CONFIRMAR

SALUDOS JOSE BAZAN
JOBARECI EIRL



POS.	CANT.	DESCRIPCIÓN	NORMA	MATERIAL	OBSERVACIONES
21	2	PERNO DE FIJACIÓN	NORMA	AISI 316L	
20	54	EMPAQUETADURA	NORMA	CAUCHO	5 MM DIÁMETRO
19	33	RESORTE	NORMA	NICROM	
18	1	TELA ELÁSTICA	NORMA	ELÁSTICO	
17	1	ACCESORIO ACOPLE	DIN ISO 2768	ABSPLUS	
16	1	ACOPLE	DIN ISO 2768	ABSPLUS	
15	1	TAPA	DIN ISO 2768	ABSPLUS	
14	1	PLACA BASE 2	DIN ISO 2768	ABSPLUS	
13	1	PLACA BASE 1	DIN ISO 2768	ABSPLUS	
12	3	PLACA PROXIMAL	DIN ISO 2768	ABSPLUS	
11	3	PLACA MEDIAL	DIN ISO 2768	ABSPLUS	
10	3	PLACA DISTAL	DIN ISO 2768	ABSPLUS	
9	3	PIEZA 6	DIN ISO 2768	ABSPLUS	
8	3	PIEZA 5	DIN ISO 2768	ABSPLUS	
7	3	PIEZA 4	DIN ISO 2768	ABSPLUS	
6	3	PIEZA 3	DIN ISO 2768	ABSPLUS	
5	6	PIEZA 2	DIN ISO 2768	ABSPLUS	
4	6	PIEZA 1	DIN ISO 2768	ABSPLUS	
3	3	PROXIMAL	DIN ISO 2768	ABSPLUS	
2	3	MEDIAL	DIN ISO 2768	ABSPLUS	
1	3	DISTAL	DIN ISO 2768	ABSPLUS	

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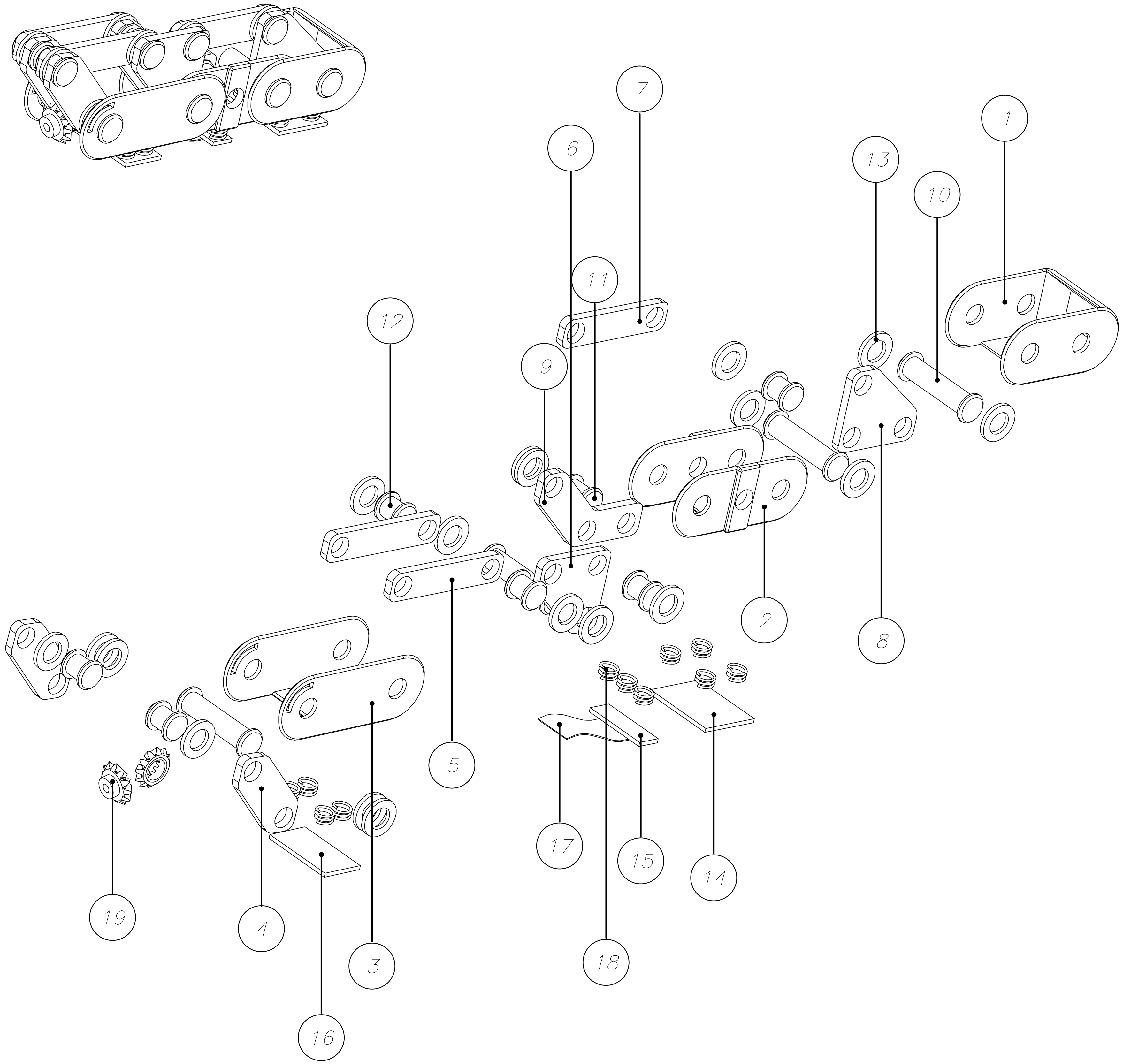
METODO DE PROYECCION	PRÓTESIS DE MANO	ESCALA 1:2
20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A3



19	2	ENGRANAJE CÓNICO	DIN 3990	LATÓN	4 PIEZAS PARA LA PRÓTESIS
18	11	RESORTES	–	NICROM	33 UNIDADES PARA LA PRÓTESIS
17	1	SENSOR DE FUERZA	–	–	3 SENSORES PARA LA PRÓTESIS
16	1	PLACA PROXIMAL	DIN ISO 2768	ABSPLUS	3 PIEZAS PARA LA PRÓTESIS
15	1	PLACA MEDIAL	DIN ISO 2768	ABSPLUS	3 PIEZAS PARA LA PRÓTESIS
14	1	PLACA DISTAL	DIN ISO 2768	ABSPLUS	3 PIEZAS PARA LA PRÓTESIS
13	18	EMPAQUETADURA ø5 mm	–	CAUCHO	54 UNIDADES PARA LA PRÓTESIS
12	6	PASADOR 3 ø5 mm	DIN ISO 2768	ABSPLUS	18 PIEZAS PARA LA PRÓTESIS
11	1	PASADOR 2 ø5 mm	DIN ISO 2768	ABSPLUS	2 PIEZAS PARA LA PRÓTESIS
10	3	PASADOR 1 ø5 mm	DIN ISO 2768	ABSPLUS	9 PIEZAS PARA LA PRÓTESIS
9	1	PIEZA 6	DIN ISO 2768	ABSPLUS	3 PIEZAS PARA LA PRÓTESIS
8	1	PIEZA 5	DIN ISO 2768	ABSPLUS	3 PIEZAS PARA LA PRÓTESIS
7	1	PIEZA 4	DIN ISO 2768	ABSPLUS	3 PIEZAS PARA LA PRÓTESIS
6	1	PIEZA 3	DIN ISO 2768	ABSPLUS	3 PIEZAS PARA LA PRÓTESIS
5	2	PIEZA 2	DIN ISO 2768	ABSPLUS	6 PIEZAS PARA LA PRÓTESIS
4	2	PIEZA 1	DIN ISO 2768	ABSPLUS	6 PIEZAS PARA LA PRÓTESIS
3	1	PROXIMAL	DIN ISO 2768	ABSPLUS	3 PIEZAS PARA LA PRÓTESIS
2	1	MEDIAL	DIN ISO 2768	ABSPLUS	3 PIEZAS PARA LA PRÓTESIS
1	1	DISTAL	DIN ISO 2768	ABSPLUS	3 PIEZAS PARA LA PRÓTESIS
POS.	CANT.	DESCRIPCIÓN	NORMA	MATERIAL	OBSERVACIONES

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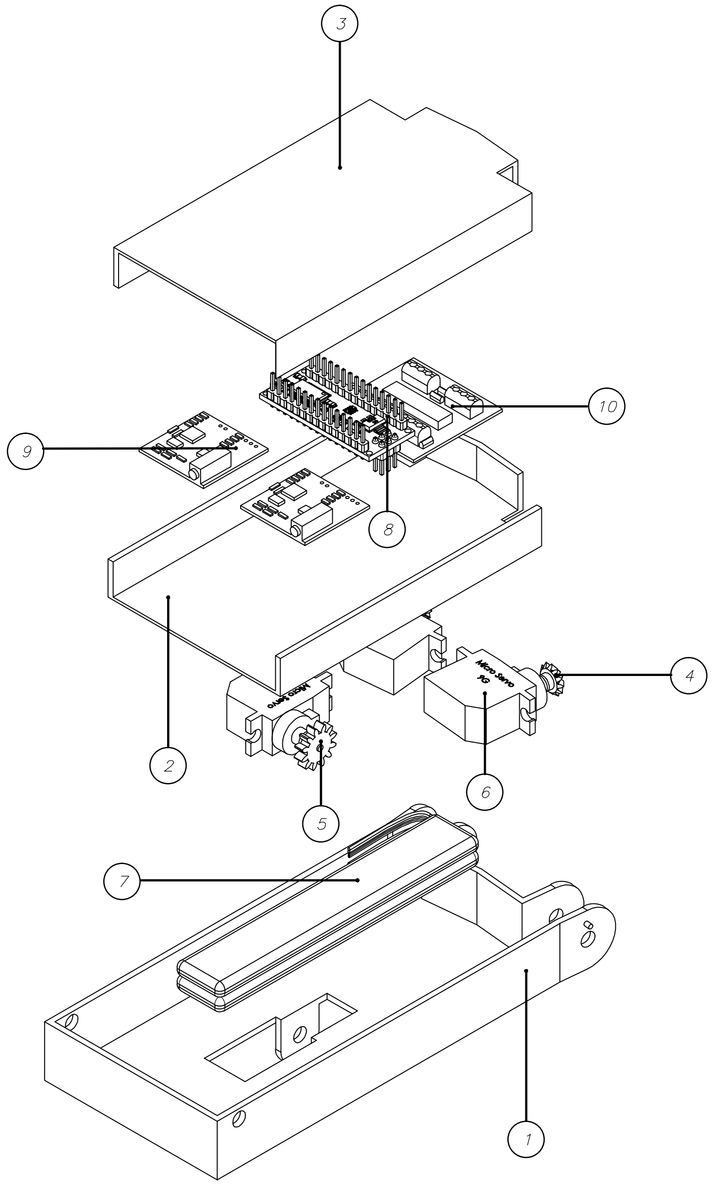
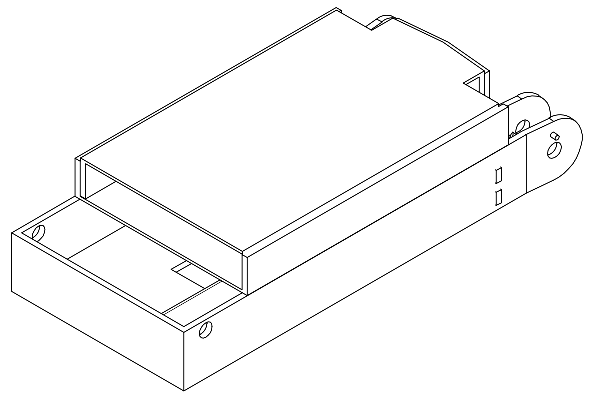
METODO DE PROYECCION	PARTES DE UN DEDO PRÓTESIS DE MANO	ESCALA 1:1
20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A3





POS.	CANT.	DESCRIPCIÓN	NORMA	MATERIAL	OBSERVACIONES
10	1	PLACA DE INTERCONEXIÓN DEL SENSOR DE FUERZA	–	–	
9	2	SENSOR DE MÚSCULO	–	–	
8	1	ARDUINO NANO 3.0	–	–	
7	2	BATERÍA DE LITIO POLÍMERO	–	–	
6	3	SERVOMOTOR	–	–	
5	1	ENGRANAJE RECTO	DIN 3990	LATÓN	2 UNIDADES PARA LA PRÓTESIS
4	2	ENGRANAJE CÓNICO	DIN 3990	LATÓN	4 UNIDADES PARA LA PRÓTESIS
3	1	TAPA	DIN ISO 2768	ABSPLUS	
2	1	PLACA BASE 2	DIN ISO 2768	ABSPLUS	
1	1	PLACA BASE 1	DIN ISO 2768	ABSPLUS	

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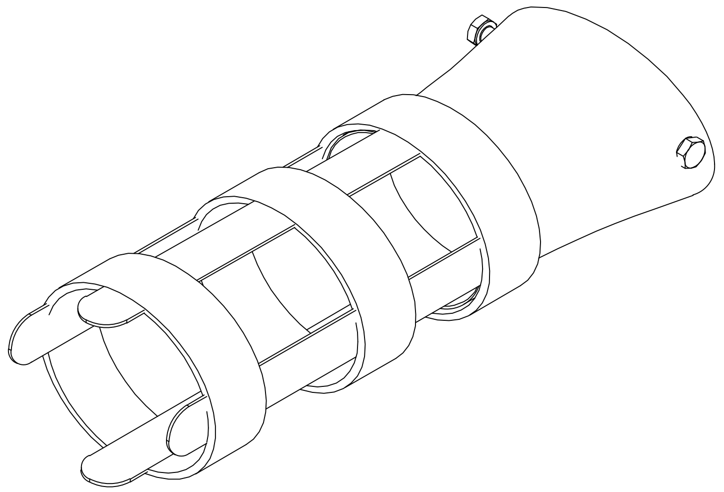
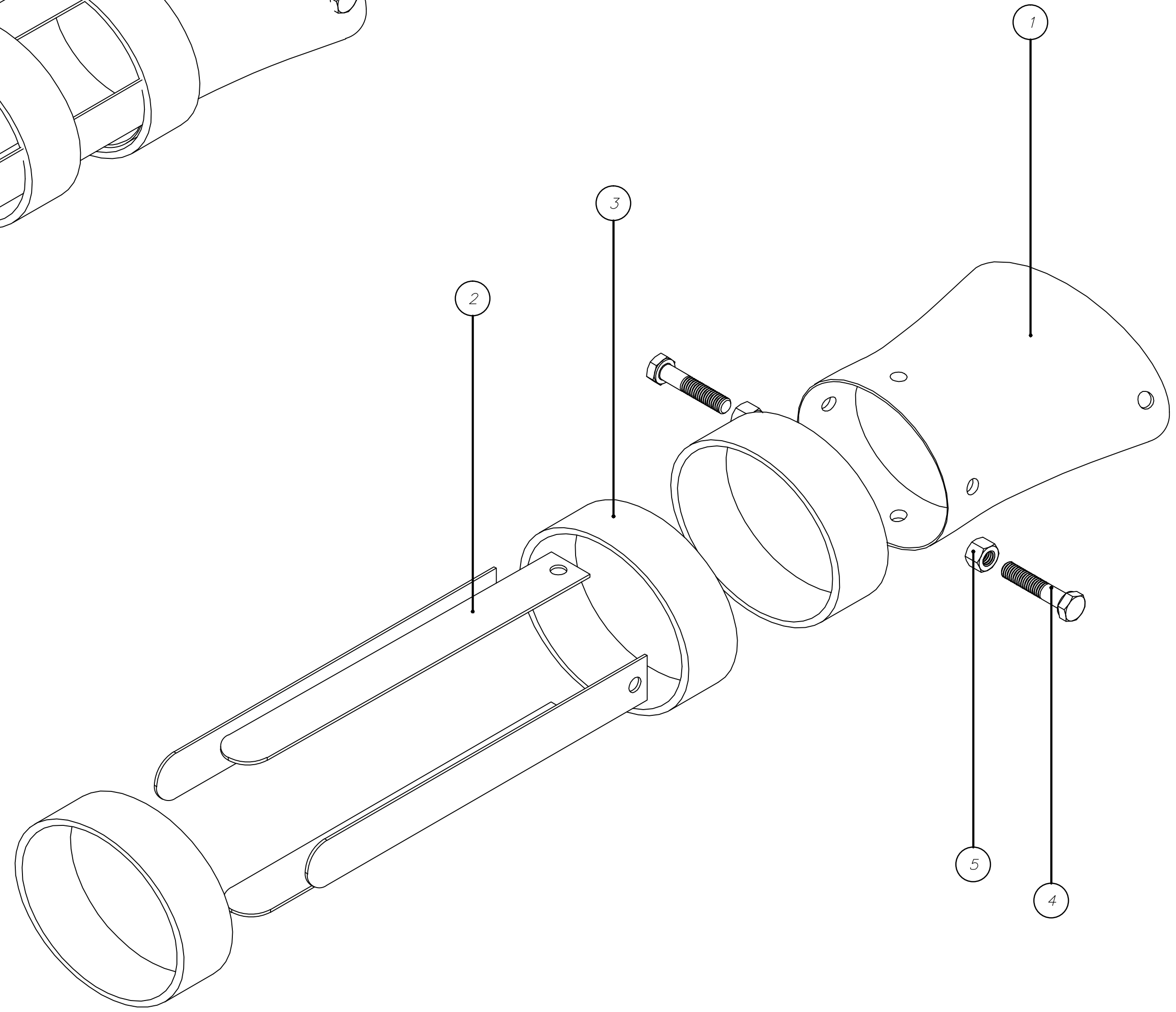
METODO DE PROYECCION	PARTES DE LA PALMA PRÓTESIS DE MANO	ESCALA 1:2
20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A3





5	2	PERNO	DIN 934	AISI 304	
4	2	TORNILLO DE FIJACIÓN	ISO 4014	AISI 304	
3	3	BRAZALETE ELÁSTICO	–	TELA ELÁSTICA	
2	4	ACCESORIO DE ACOPLE	DIN ISO 2768	ABSPLUS	
1	1	ACOPLE	DIN ISO 2768	ABSPLUS	
POS.	CANT.	DESCRIPCIÓN	NORMA	MATERIAL	OBSERVACIONES

PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERÚ
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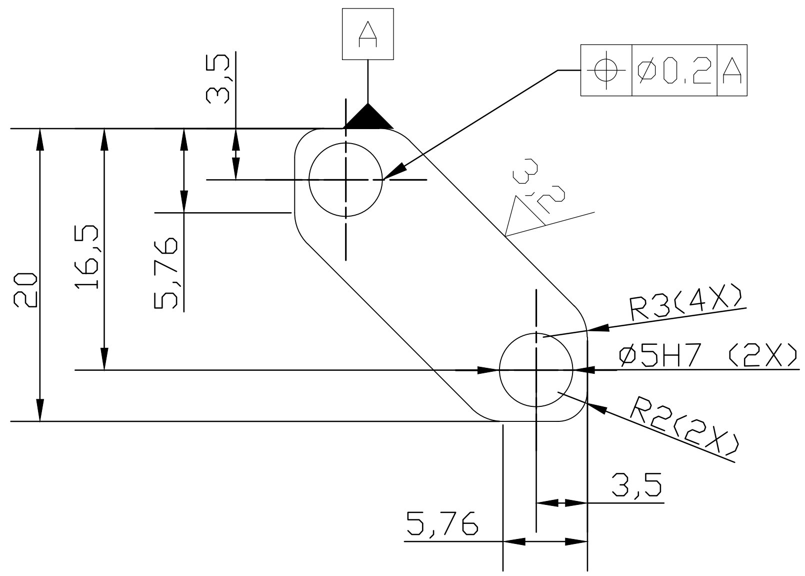
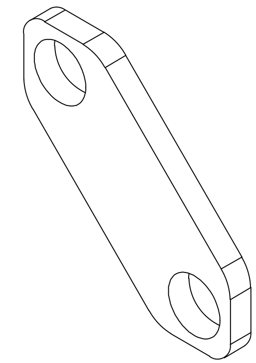
METODO DE PROYECCION	ACOPLE PRÓTESIS DE MANO	ESCALA 1:2
20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A3





Espesor 2 mm

ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN-ISO-2768 T1	ABSPLUS

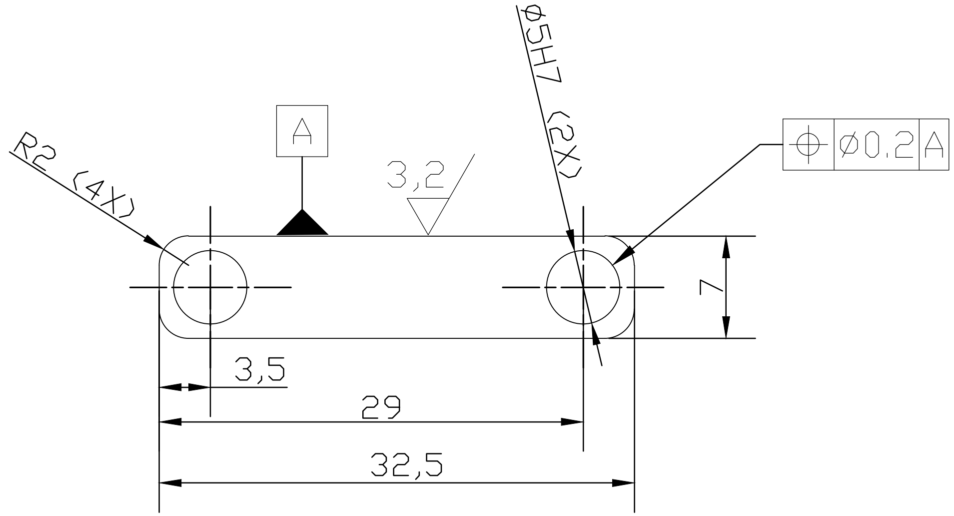
PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU
FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

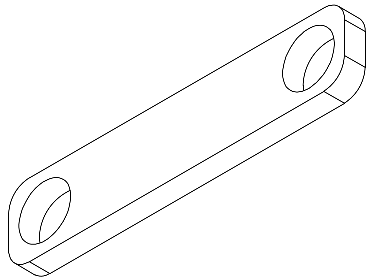
METODO DE PROYECCION	PIEZA 1 PRÓTESIS DE MANO	ESCALA 2:1
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4

TOLERANCIAS DIMENSIONALES
SEGUN DIN ISO 2768 T1

GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5

5H7	5.021	5.000
COTA NOMINAL	COTA MAXIMA	COTA MINIMA





Espesor 2 mm

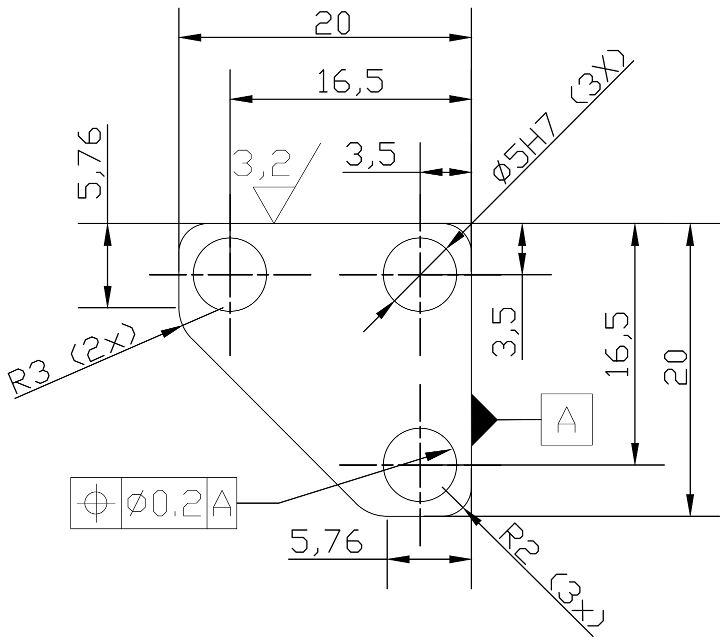
ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN-ISO-2768 T1	ABSPLUS

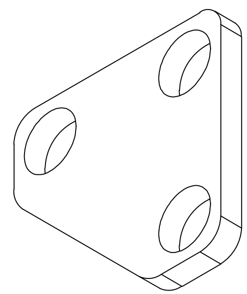
PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU
FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

METODO DE PROYECCION	PIEZA 2 PRÓTESIS DE MANO	ESCALA 2:1
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4

TOLERANCIAS DIMENSIONALES SEGUN DIN ISO 2768 T1					
GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5

5H7	5.021	5.000
COTA NOMINAL	COTA MAXIMA	COTA MINIMA





Espesor 2 mm

ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN-ISO-2768 T1	ABSPLUS

PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU

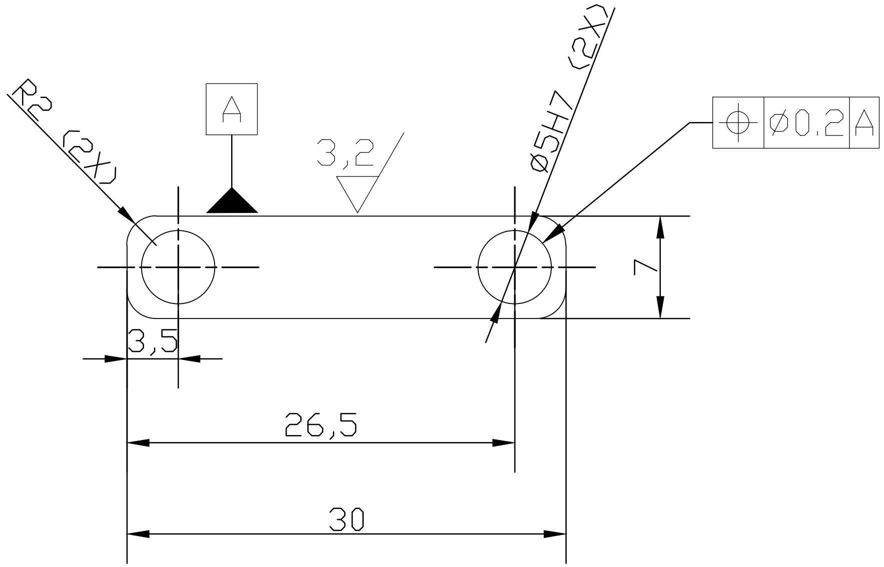
FACULTAD DE CIENCIAS E INGENIERÍA - ESPECIALIDAD: ING. MECATRÓNICA

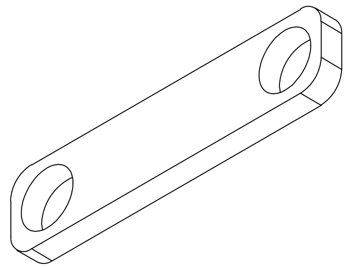
METODO DE PROYECCION		ESCALA
	PIEZA 3 PRÓTESIS DE MANO	2:1
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4

5H7	5.021	5.000
COTA NOMINAL	COTA MAXIMA	COTA MINIMA

TOLERANCIAS DIMENSIONALES SEGUN DIN ISO 2768 T1

GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5





Espesor 2 mm

ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN-ISO-2768 T1	ABSPLUS

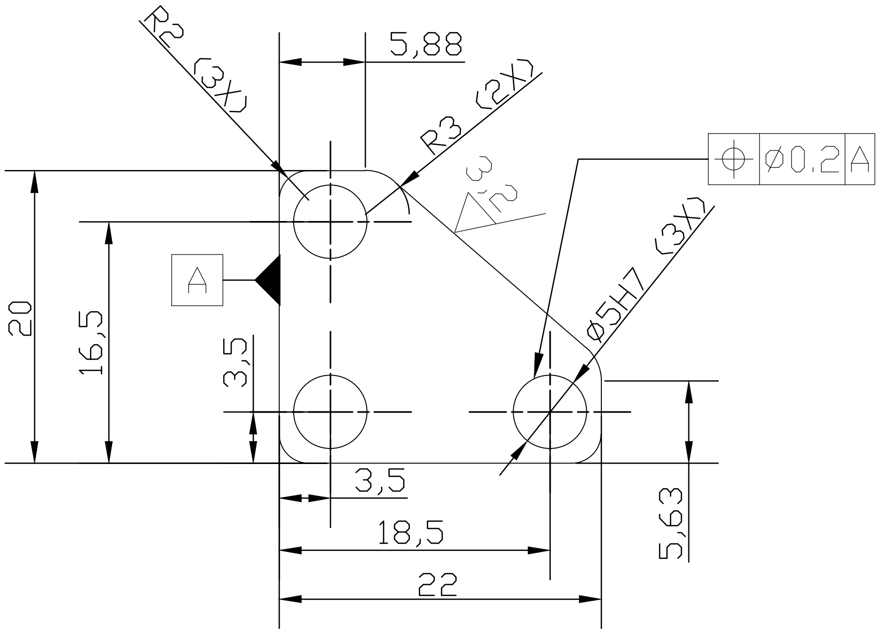
PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU
FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

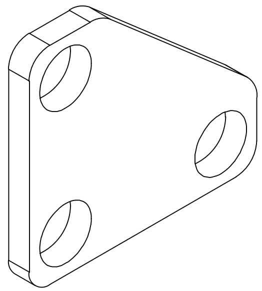
METODO DE PROYECCION		ESCALA
	PIEZA 4 PRÓTESIS DE MANO	2:1
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4

TOLERANCIAS DIMENSIONALES
SEGUN DIN ISO 2768 T1

GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5

5H7	5.021	5.000
COTA NOMINAL	COTA MAXIMA	COTA MINIMA





Espesor 2 mm

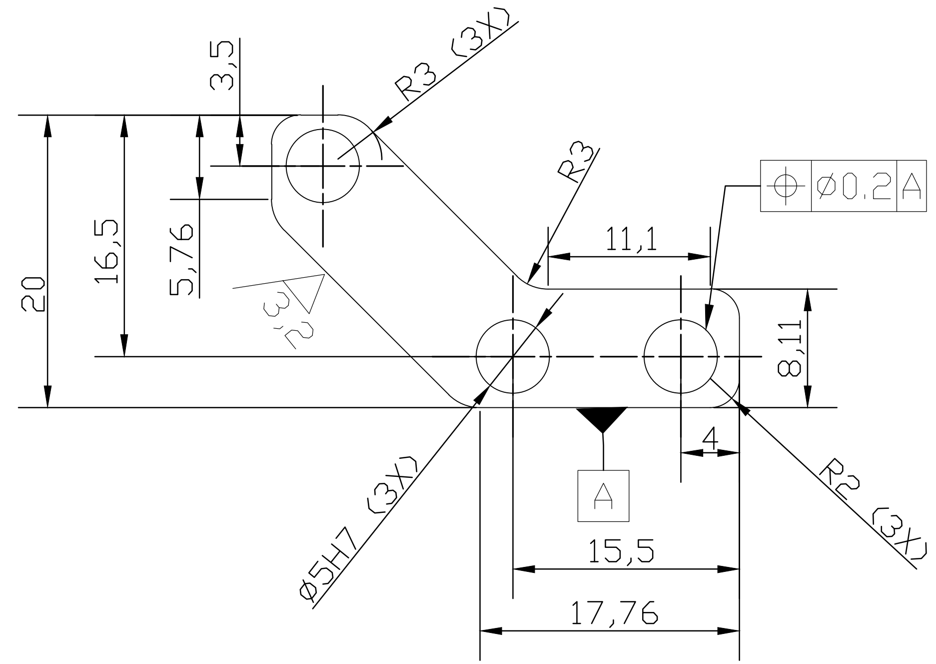
ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN-ISO-2768 T1	ABSPLUS

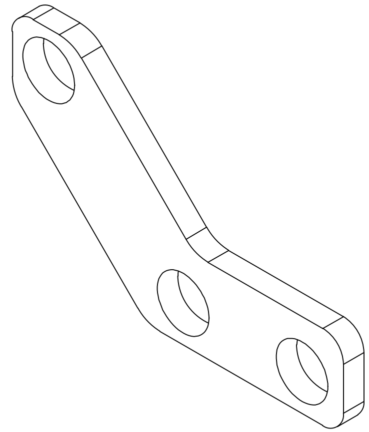
PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU
FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

METODO DE PROYECCION	PIEZA 5 PRÓTESIS DE MANO	ESCALA 2:1
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4

TOLERANCIAS DIMENSIONALES SEGUN DIN ISO 2768 T1					
GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5

5H7	5.021	5.000
COTA NOMINAL	COTA MAXIMA	COTA MINIMA





Espesor 2 mm

TOLERANCIAS DIMENSIONALES SEGUN DIN ISO 2768 T1					
GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5

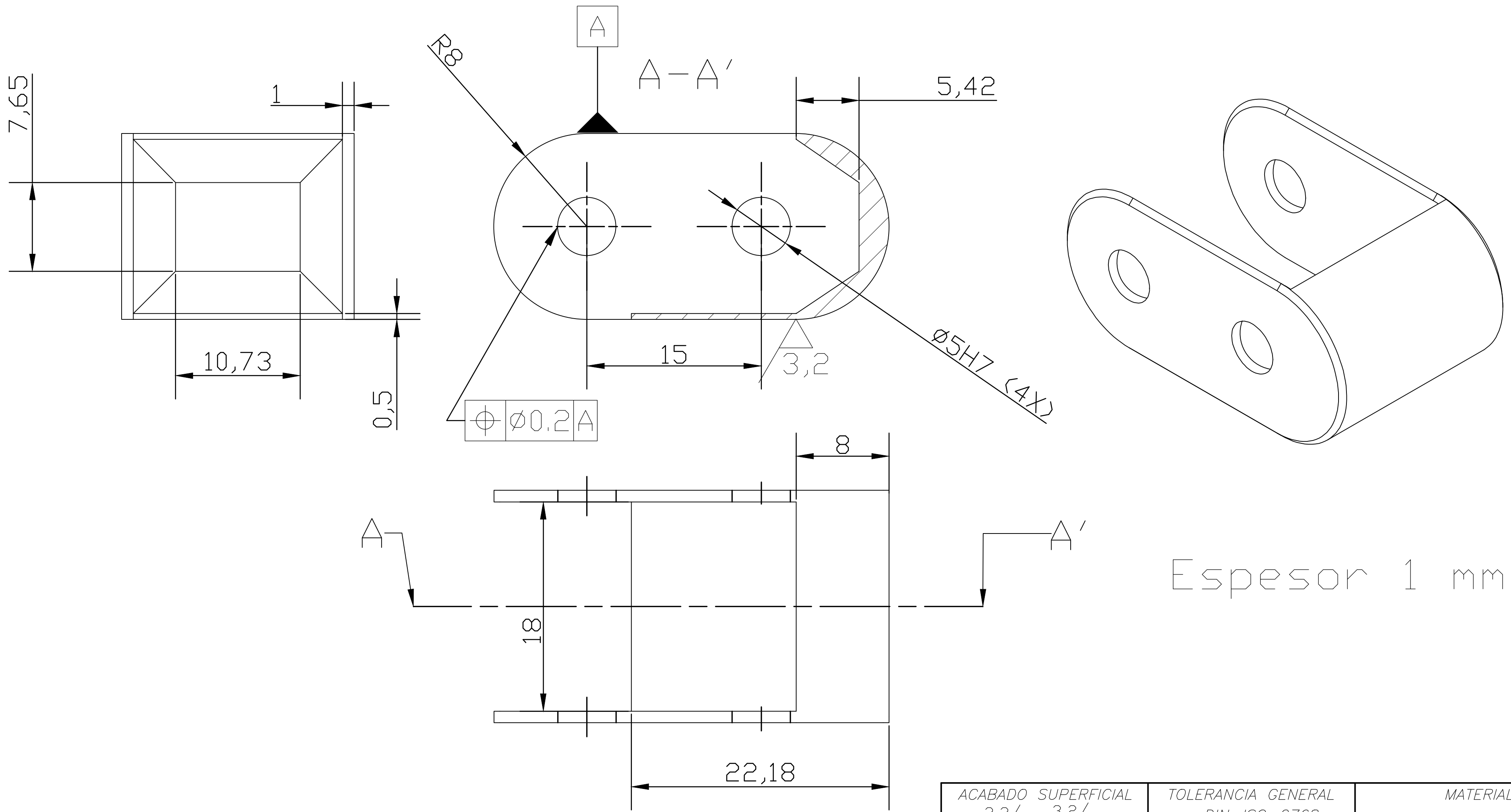
5H7	5.021	5.000
COTA NOMINAL	COTA MAXIMA	COTA MINIMA

ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN-ISO-2768 T1	ABSPLUS

PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU

FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

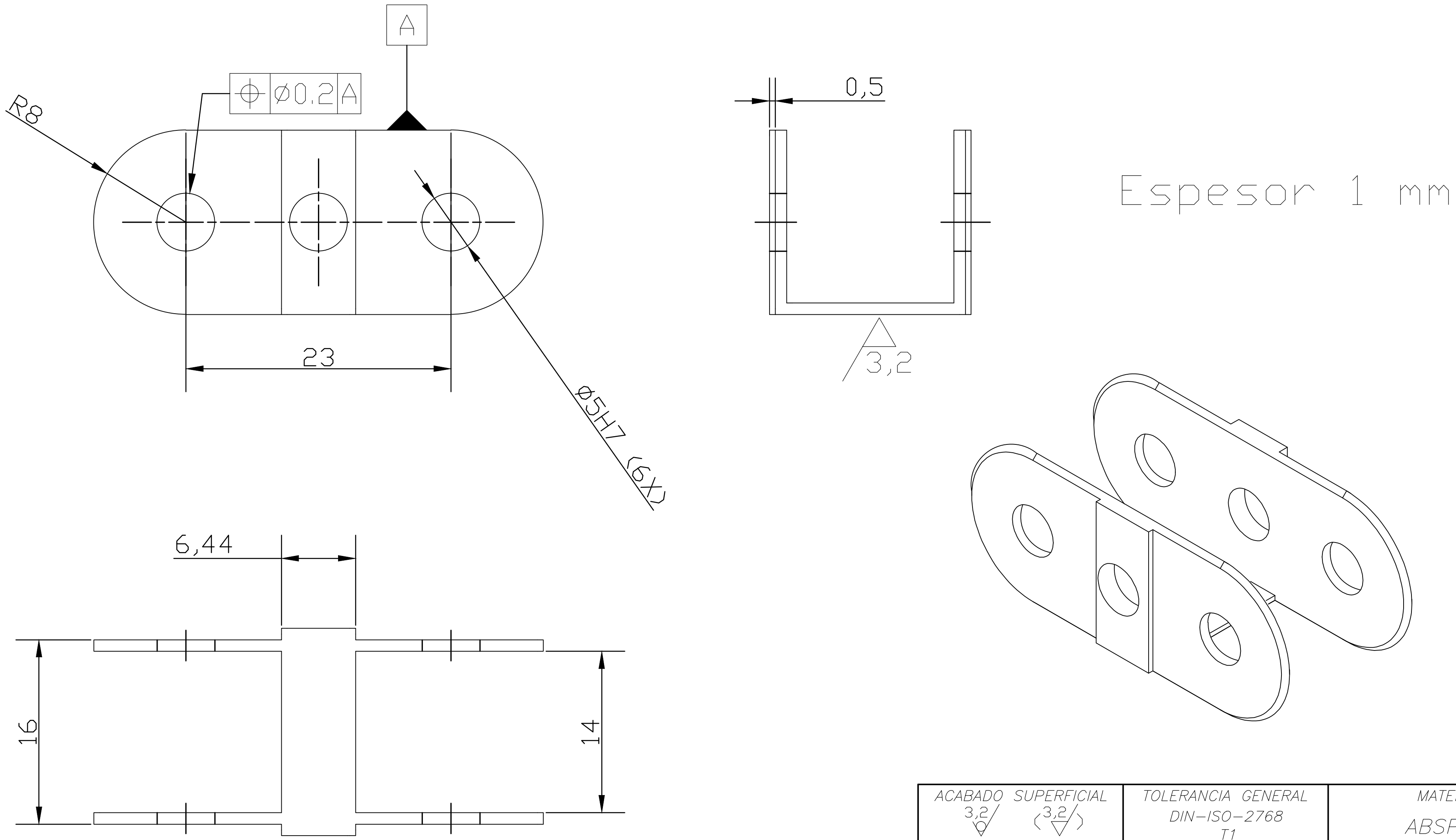
METODO DE PROYECCION	PIEZA 6 PRÓTESIS DE MANO	ESCALA 2:1
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4



TOLERANCIAS DIMENSIONALES SEGUN DIN ISO 2768 T1					
GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5

5H7	5.021	5.000
COTA NOMINAL	COTA MAXIMA	COTA MINIMA

ACABADO SUPERFICIAL 3,2 (3,2)	TOLERANCIA GENERAL DIN–ISO–2768 T1	MATERIAL ABSPLUS
PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA		
METODO DE PROYECCION	DISTAL PRÓTESIS DE MANO	ESCALA 2:1
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4



ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN–ISO–2768 T1	ABSPLUS

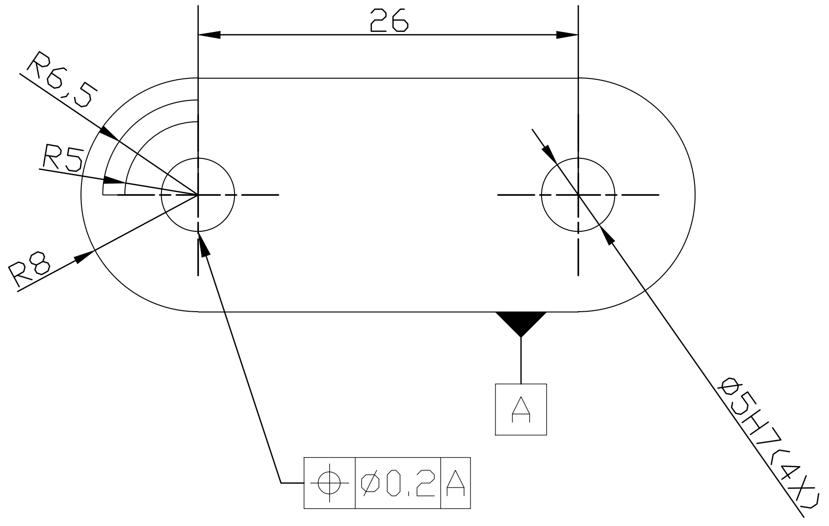
PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERÚ

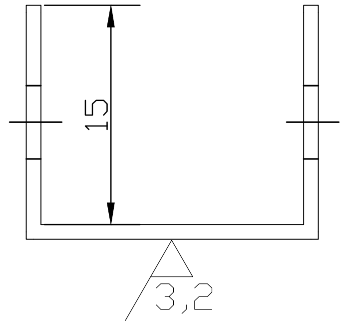
FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

METODO DE PROYECCION		ESCALA
	MEDIAL PRÓTESIS DE MANO	2:1
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4

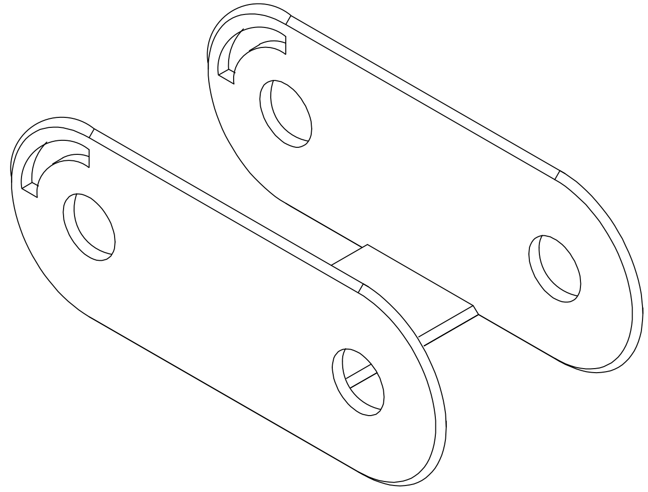
TOLERANCIAS DIMENSIONALES SEGUN DIN ISO 2768 T1					
GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5

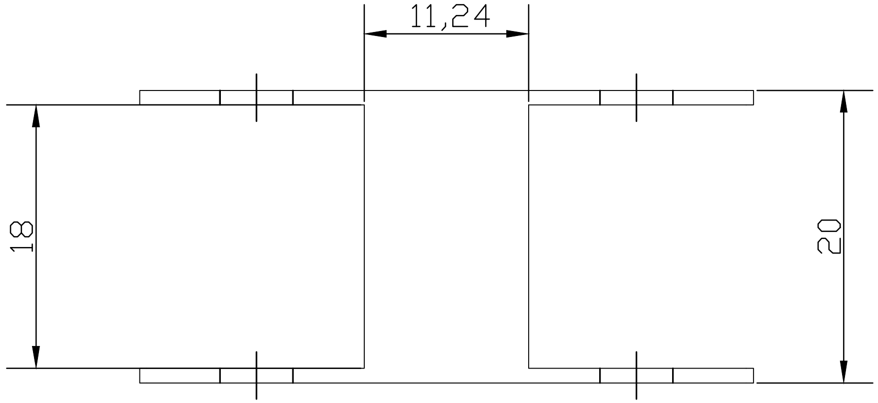
5H7	5.021	5.000
COTA NOMINAL	COTA MAXIMA	COTA MINIMA





Espesor 1 mm





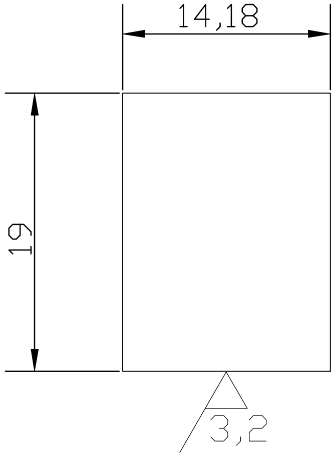
TOLERANCIAS DIMENSIONALES SEGUN DIN ISO 2768 T1					
GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5

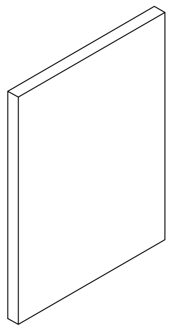
5H7	5.021	5.000
COTA NOMINAL	COTA MAXIMA	COTA MINIMA

ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN–ISO–2768 T1	ABSPLUS

PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERÚ
FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

METODO DE PROYECCION	PROXIMAL PRÓTESIS DE MANO	ESCALA 2:1
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4





Espesor 1 mm

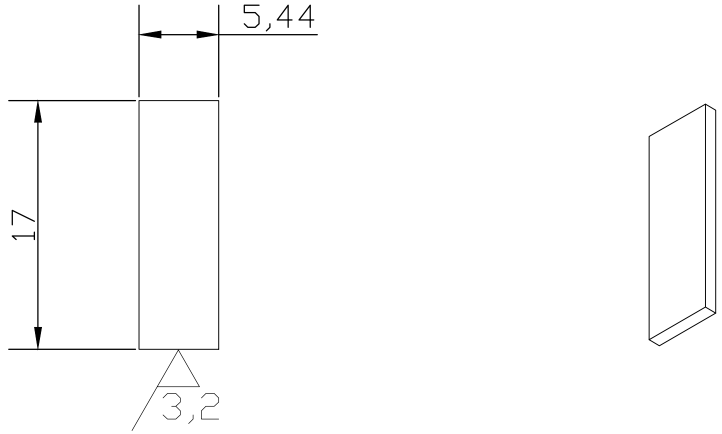
TOLERANCIAS DIMENSIONALES SEGUN DIN ISO 2768 T1					
GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5

ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN-ISO-2768 T1	ABSPLUS

PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU

FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

METODO DE PROYECCION		ESCALA
	PLACA DISTAL PRÓTESIS DE MANO	2:1
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4



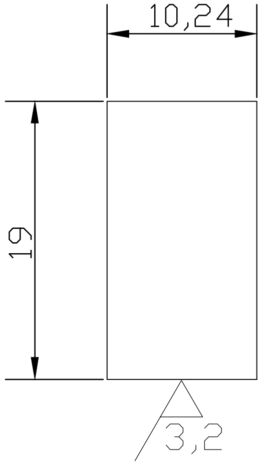
Espesor 1 mm

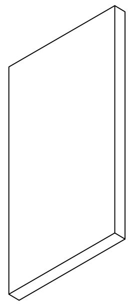
TOLERANCIAS DIMENSIONALES SEGUN DIN ISO 2768 T1					
GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5

ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN-ISO-2768 T1	ABSPLUS

PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU
FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

METODO DE PROYECCION	PLACA MEDIAL PRÓTESIS DE MANO	ESCALA 2:1
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4





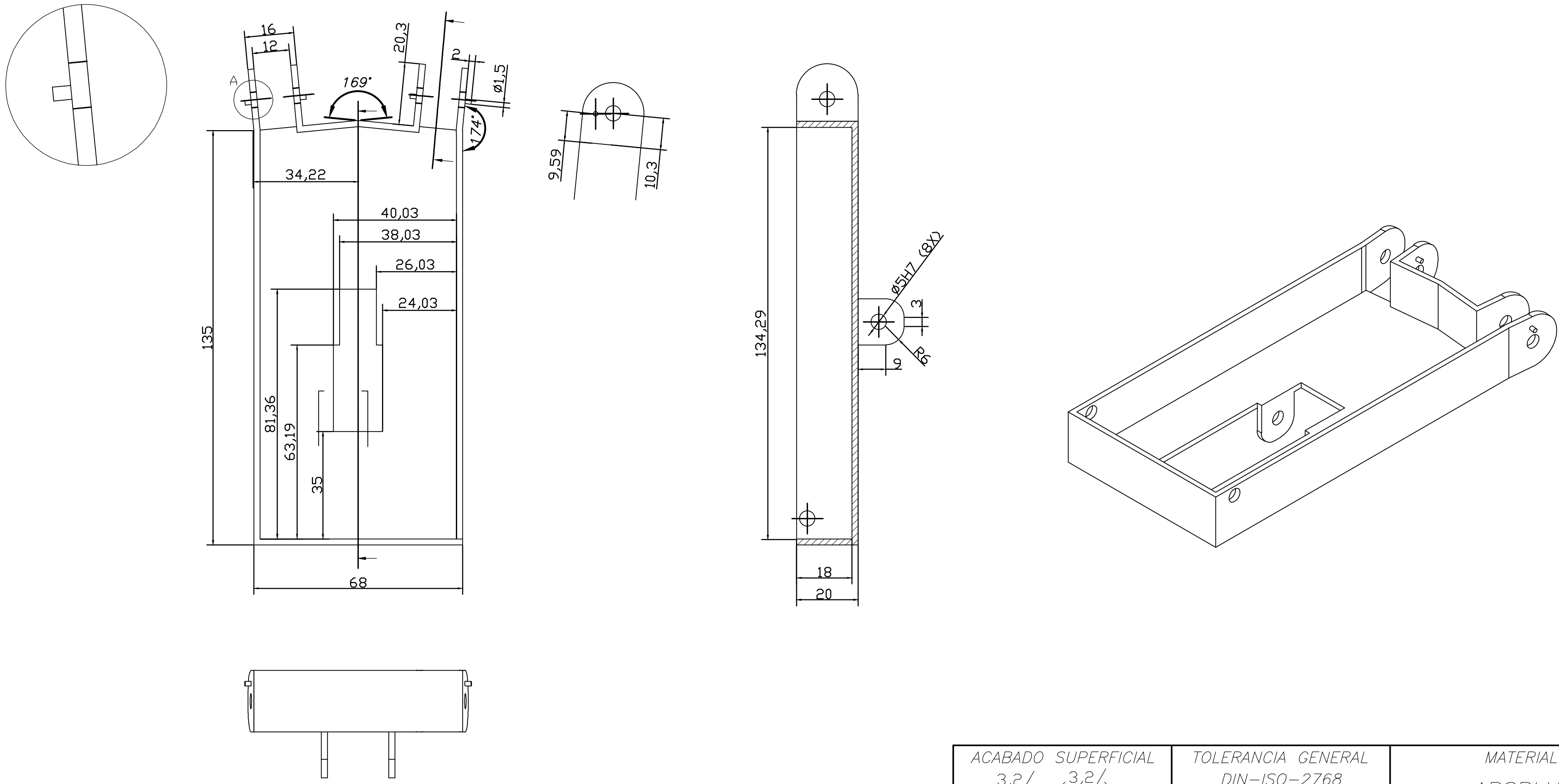
Espesor 1 mm

TOLERANCIAS DIMENSIONALES SEGUN DIN ISO 2768 T1					
GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5

ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN-ISO-2768 T1	ABSPLUS

PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU
FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

METODO DE PROYECCION	PLACA PROXIMAL PRÓTESIS DE MANO	ESCALA 2:1
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4



ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN-ISO-2768 T1	ABSPLUS

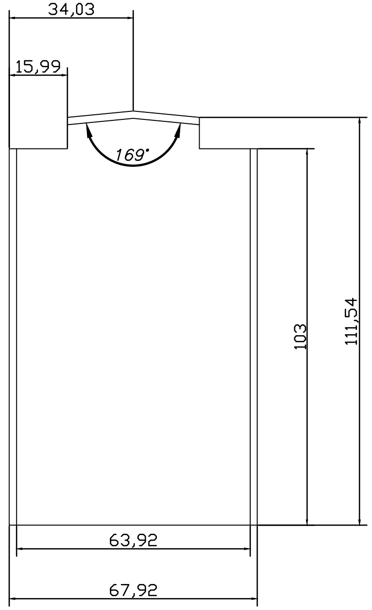
PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU
FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

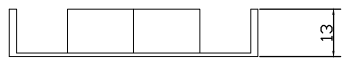
METODO DE PROYECCION	PALMA BASE 1 PRÓTESIS DE MANO	ESCALA 1:2
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4

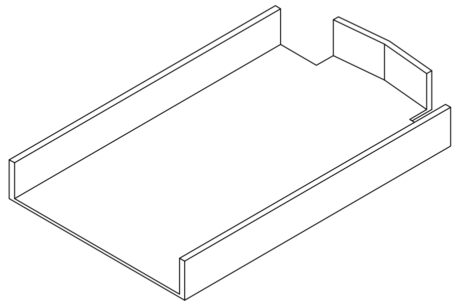
5H7	5.021	5.000
COTA NOMINAL	COTA MAXIMA	COTA MINIMA

TOLERANCIAS DIMENSIONALES
SEGUN DIN ISO 2768 T1

GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5







ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN-ISO-2768 T1	ABSPLUS

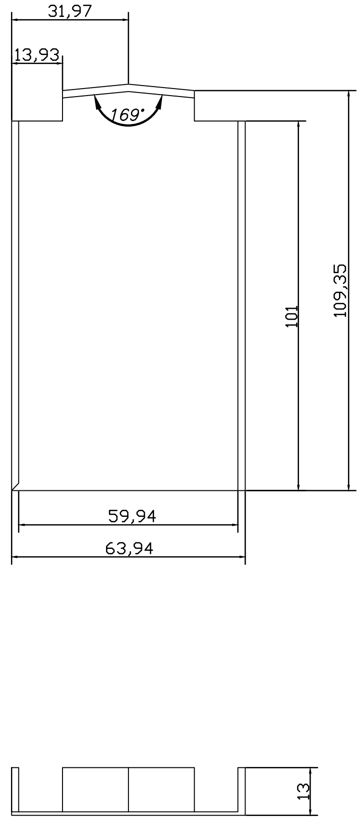
PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU

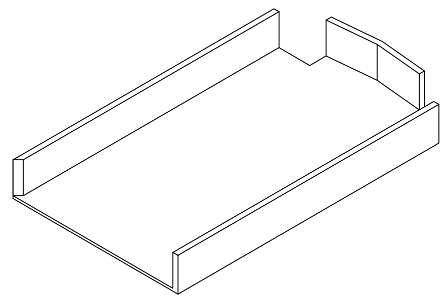
FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

METODO DE PROYECCION		ESCALA
	PALMA BASE 2 PRÓTESIS DE MANO	1:2
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4

TOLERANCIAS DIMENSIONALES SEGUN DIN ISO 2768 T1

GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5





ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN–ISO–2768 T1	ABSPLUS

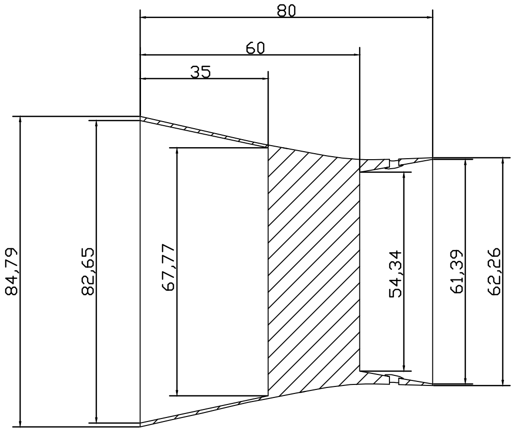
PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU

FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

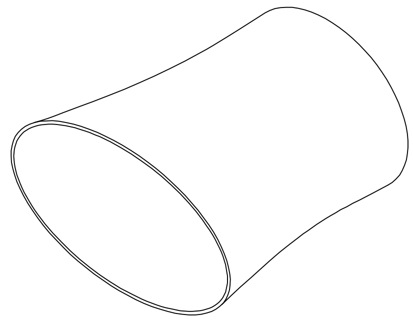
METODO DE PROYECCION	TAPA PRÓTESIS DE MANO	ESCALA 1:2
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4

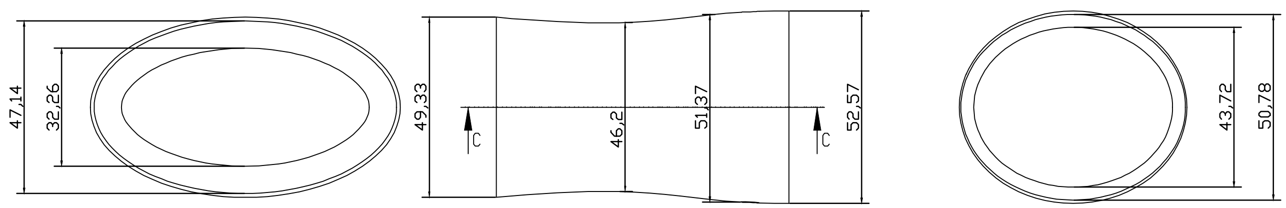
TOLERANCIAS DIMENSIONALES SEGUN DIN ISO 2768 T1

GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5



SECCIóN C-C





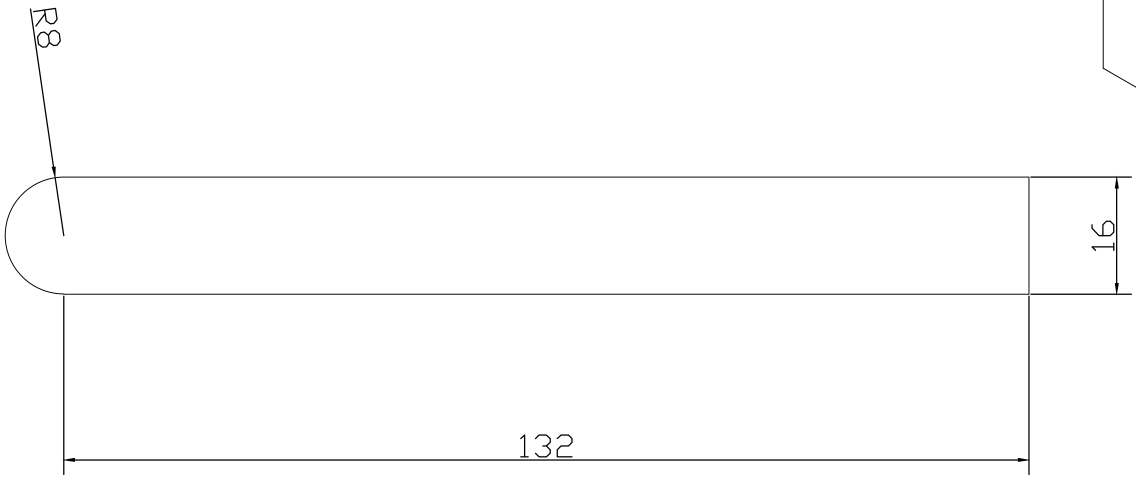
ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN-ISO-2768 T1	ABSPLUS

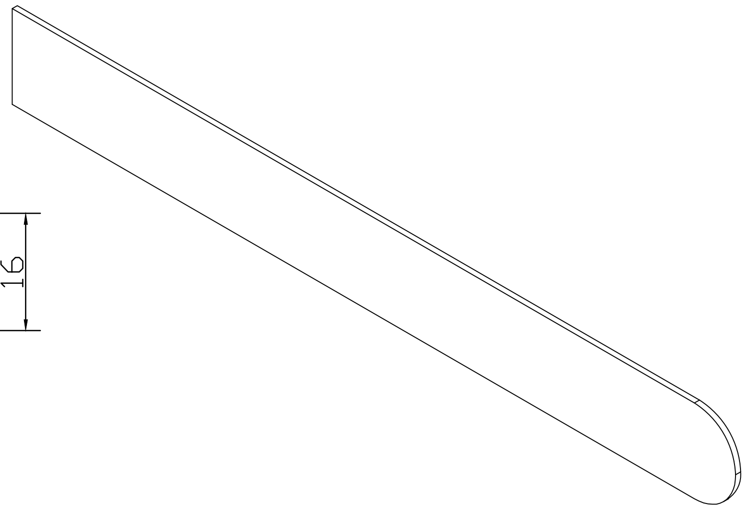
PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU

FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

METODO DE PROYECCION	ACOPLE PRÓTESIS DE MANO	ESCALA 1:2
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4

TOLERANCIAS DIMENSIONALES SEGUN DIN ISO 2768 T1					
GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5





ESPESOR 1 mm

TOLERANCIAS DIMENSIONALES SEGUN DIN ISO 2768 T1					
GRADO DE EXACTITUD	Más de 0,5 hasta 3	Más de 3 hasta 6	Más de 6 hasta 30	Más de 30 hasta 120	Más de 120 hasta 400
MEDIO	±0,1	±0,1	±0,2	±0,3	±0,5

ACABADO SUPERFICIAL	TOLERANCIA GENERAL	MATERIAL
3,2 (3,2)	DIN-ISO-2768 T1	ABSPLUS

PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU
FACULTAD DE CIENCIAS E INGENIERÍA – ESPECIALIDAD: ING. MECATRÓNICA

METODO DE PROYECCION	ACESSORIO ACOPLE PRÓTESIS DE MANO	ESCALA 1:1
CÓDIGO: 20087197	SALAS CASAPINO, CARLOS ALBERTO	FECHA: 03/07/2014
		LAMINA: A4